FLAX, TOW, AND JUTE SPINNING:

A HANDBOOK

CONTAINING INFORMATION ON THE VARIOUS BRANCHES OF THESE TRADES.

WITH

RULES, CALCULATIONS, AND TABLES.

BY

PETER SHARP.

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PREFACE TO FIRST EDITION.

It seems strange that, while in almost every branch of our national manufactures there are printed works for the instruction and guidance of those employed, there should be none on Flax, Tow, and Jute Spinning. It may without injustice be said that the majority of our overseers know only what on the subject they can glean from conversation with those who have acquired the necessary knowledge by years of labour. Oral information on any subject, especially if difficult to obtain, must of necessity be more or less imperfect, since it requires patient and close study to acquire a thorough knowledge of the various parts of the machinery, their relations to each other, the points of dependence of the several parts, tabulated calculations, rules for determining relative speeds, &c. It was the consideration of these facts that prompted me to come forward with the hints contained in these pages, which, however imperfect, will, I trust, be of service to those who may have to struggle through the technical difficulties of our trade.

PETER SHARP.

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FLAX: ITS CULTIVATION, AND TREATMENT PRIOR TO SPINNING.

HAD my experience of the spinning trade been limited to Ireland I should not have attempted in these pages to give a description of the cultivation of flax and the various processes through which it passes previous to reaching the spinner, as its cultivation in that country is so general that few persons residing there can fail to acquire a knowledge of the growing of flax and its treatment prior to its leaving the hands of the farmer. In Scotland and England it is different; the plant is rarely cultivated in these countries, hence it is almost impossible to practically acquire this knowledge. Under these circumstances, it may add to the interest of this work if we give a short description of the flax plant, and the manner in which it is grown and manipulated previous to its coming into the hands of the spinner.

The botanical name of the flax plant, which is so much cultivated all over the world, growing wild in Egypt and some parts of Asia, is *Linum Usitatissimum*. It is an annual. It is cultivated in this country in summer; in Egypt it ripens and comes to perfection in the winter. The *Linum Catharticum* is the only plant of this family indigenous to these countries. As its name implies, it possesses laxative and diuretic properties, and is still occasionally gathered and administered as a domestic medicine. In Latin the generic name is *linum*, in Greek it is *linon*, in German *lein*, in French *lin*, in Irish *len*, in Welsh *llin*, in Russian *lenn;* in Scottish, anciently *lin*, now *lint;* in Egyptian, according to Dr Birch, it was *shenu*.

The flax plant grows to a height of from three to four feet under cultivation; the stem branches more or less according to the degree to which it is crowded by the other plants. The leaves are alternate, linear, lanceolate, and, like the stem, smooth. The flowers, arranged in a loose panicle, are about an inch in diameter. The parts of the flower are very regular, and are all in fives. The calyx consists of five green sepals; the petals are large, of a fine purplish blue colour, and fall very soon after the flower opens. Within the petals are five stamens surrounding the pistil, which consists of an ovary and five separate styles. The ovary, or lower part of the pistil, in ripening becomes the seed vessel or boll. As it matures the styles fall away, leaving a little point at the top of the boll. When the young ovary is cut through at flowering time it only shows five cells or divisions, with two ovules in each. As the ovules mature to become seeds a partition is formed through each of these cells or divisions, so that the ripe boll, when cut open, appears ten-celled, with a seed in each cell. The seed is too well known to require description. Its skin is smooth and polished, being covered with a kind of mucilage, which is readily soluble in hot water. This mucilage, dissolved in water, is popularly used, under the name of "flax-seed tea," as a bland and soothing drink in various inflammatory diseases. The seeds contain a large quantity of oil, and the plant is often cultivated for this product alone. By cold expression 18 to 20 per cent. of oil is obtained, and by the aid of heat 22 to 27 per cent. The seeds are usually heated before they are pressed, as the yield of oil is greater, and it is much freer of mucilage than that obtained by pressing the seeds without heat. The most powerful hydraulic presses are used in expressing the oil from flax seed, the seed being previously bruised by heavy rollers; and the product, the linseed oil, is largely used in painting. When exposed to the air it gradually thickens, and finally dries into a hard transparent varnish. This drying property, which makes it so useful in painting, is due to the absorp-

tion of oxygen from the air, and this tendency is much increased by boiling it with litharge and other substances. This oil, just as it comes from the press, is known in commerce as "raw oil," while the other is called "boiled oil." The cake left in the press after the oil has been extracted is known as oilcake, and is much used as a food for cattle. It is, however, the fibre which gives the flax plant its greatest value. A stem of the plant having been cut across, we find the centre occupied by pith; outside this is a layer of ordinary woody fibres; then the liber or inner bark, which consists of very long and remarkably tough fibres; and, outside all, a bark covered by a skin or epidermis. The object of all the processes of rotting, breaking, scutching, &c., is to separate the fibres of the liber or inner bark from all the other portions. Ireland is the only one of our three countries which grows flax to any extent; Scotland grows none (although attempts are now being made to reintroduce its cultivation), and England very little. The selection of proper soil for flax is an important matter; a sound, deep, friable loam is generally accepted as the best. I do not profess to know, and if I did it would not be my province to go into the flax agriculturist's experience of the soil which grows the best and most profitable crops: it is sufficient to know that flax requires the same care in this respect that any of our ordinary cereals do. The preparation of the soil is another important matter, but I may say, as in the last case, that the primary preparations are similar to those of ordinary grain crops. The seed generally used in Ireland is Riga and Dutch, very little home-grown being sown. On the thickness of the sowing, however, depends to a certain extent the quality of the fibre, 2 to 2½ bushels per English statute acre being an average. When flax is grown principally for the seed, it is sown thinly; and a characteristic of the flax plant is that, when sown thin, it throws out a great number of branches in bush form, rendering the fibre coarse, but giving a large yield of seed. When sown thickly, it grows in the form of a straight stalk, with only small

leaves branching out at short intervals, and on the top it carries only a few seed bolls. After the flax attains one or two inches in height, it is carefully weeded, every precaution being taken to avoid crushing the young plant during the process. After this, little attention is needed until the flax attains its full growth. The proper time to pull the flax is a much disputed point. The state of the bolls is the means by which it is generally determined, some pulling it when they are in an almost green state, others when they turn yellow, while the majority pull it when in a medium state. By early pulling a fine quality of fibre is obtained. In the oldest state a greater yield is obtained, but the medium produces the greatest possible amount of fibre compatible with a good marketable quality. Some determine the state of the flax by the appearance of the stalk, and begin pulling when from one-third to two-thirds of the stalk is yellow from the bottom.

Instead of cutting the flax, like other cereal crops, the stalks are pulled, which is a simple process, the plants being caught near the middle with the right hand and pulled or jerked out by the root, the root being only two or three inches long. Care must be exercised in keeping the roots all even, as otherwise a great amount of unnecessary work is added to the subsequent processes, and hacklers know how troublesome badly handled and uneven flax is to deal with. In this matter of evenness Archangel flax is the best cared for among Russian flaxes. Continental flaxes, such as Flemish or French. are also usually very well handled. Up to this stage flax cultivation generally is much the same, but the subsequent processes vary in detail in the same and different countries. In order to free the fibre from the woody part, or rather to remove the gummy substance which causes them to adhere, rotting the woody part is resorted to. For this purpose the flax is put into dams filled with water, these are called retting or rotting dams, and this process is by far the most delicate operation the flax undergoes. Referring to the description of the plant

previously given, the fibre is shown to be on the outside, so to speak, and not on the inside, as is often supposed, and hence the great difficulty in getting rid of this wood.

Retting dams vary in size; in Ireland they are generally about twenty-five feet long by ten feet wide and four feet deep. They must be thoroughly watertight, and after the flax is put in no water is admitted or run off until the flax is taken out. Water containing lime is always avoided, and iron in it gives the flax a rusty, or what spinners call a foxy, colour.

The colour is also affected by other causes. Much depends on the nature of the soil in which the dam is. In Ireland a rich blue, or what is called a clay colour, is liked best. The beets or sheaves are now put into the dam in rows, roots downwards, one row above the other until the dam is full, then they are covered with rag-weeds and sods, and sunk with stones until the flax is below the surface. Now comes the necessity for close attention on the part of the farmer. If the weather is warm fermentation sets in after a day or two, and the flax is generally ready for taking out on the thirteenth or fourteenth day. About this time take three or four reeds, and you will find that they are covered with a greenish substance. If the fibre can be removed from the surface by delicately passing it through the finger and thumb, it is an unmistakeable sign that it is in a condition to leave the dam. Again, if by gently bending them over the forefinger the woody part starts from the fibre, it is clearly in a condition to be taken out. Another way is to take ten inches or so of the stalk, and, if ready, the wood or bone should draw out clean from the fibre without breaking. The beets are then distributed at convenient distances across a field, and spread out thinly and evenly in rows. A process of steeping in tanks in hot water has been tried by Schenk, &c., and indeed English flax, which is principally grown about Selby, in Yorkshire, is hot-water steeped, and a great many different ways have been suggested and tried to make this operation safer and surer.

A day or two after being spread the fibre is very unwilling to leave the wood, but in another day or two it contracts, and by rubbing between the fingers the wood will crack and fly off; then it is ready for lifting, tying in bunches, and storing for the scutch-mill. Another method, and one which is said to improve the quality of the flax, is to put it in stooks in the field and dry it, stack it until the succeeding year, and then put it through steeping and grassing as before. The best flax got from the Continent (Courtrai) is steeped in running water—the river Lys—which, although not stagnant, has the property of causing fermentation, and gives it a fine cream colour. The finest qualities of this flax, after being steeped and dried, are stacked until the following year, and then steeped a second time. The highest price for this flax would now be about £160 per ton, but flax has been bought for a special purpose, costing £235 per ton, a great contrast when compared with low Russian at, say, £24.

Scutching.—We now come to the scutching—a process for separating the wood from the fibre, and most of us know that very often it is not well done. There are two ways adopted, mill or power, and hand-scutching. In Ireland it is mostly mill-scutched, and the process is as follows:—The flax is taken to the mill after grassing, and its first process is to go through three fluted iron rollers for the purpose of breaking the wood into small bits, leaving the stalks pliable and so manageable by the scutching handle. This machine is very simple in construction. On a shaft driven by water or steam, making about 200 revolutions per minute, we have the handle, which is similar in appearance to the blade of a wind-mill, having three blades made of wood, and, like a butcher's chopper, thick at the back and tapering on one side to a pretty sharp edge, the plain side being placed next the stock. This handle is made to revolve close to a wooden or metal upright stock, at the back of which the man stands, putting the flax over the top and allowing the blades to strike it and so clear off the wood. On the Continent

flax is principally hand-scutched. In some parts of Ireland the hand-scutching system prevails, but as practised there it is injurious to the flax. This process is as follows:—The flax is taken, after being on the grass, and spread over a rack, underneath which is placed a low fire of peats, which causes the woody part to become brittle, but at the same time robs the fibre of a certain amount of its oily nature, which, of course, deteriorates its value. It is then placed on a fluted hardwood board called a flax breaker, and another board is made to close on it, thus breaking the wood which has been rendered extra brittle by fire. It is then placed on a wooden erection and scutched by hand. On the Continent they are much more careful. They use no fire, and clean the fibre with much patience, diligence, and care, especially in Holland, Belgium, and France, thus obtaining a higher price. The Russians generally prepare their flax very badly, and attempts are being made to get the Russian Government to disseminate better knowledge as to its proper manipulation.

For the following tables we are indebted to the Secretary of the Flax Supply Association, Belfast:—

FLAX GROWN IN EUROPE.

Countries.	Statute Acres.	Stones per Acre	Tons.
Austria,	178,366	49·20	54,852
Hungary,	50,417	40·98	12,915
Belgium,	53,545	—	—
France,	66,398	56·07	23,356
Germany,	83,147	—	—
Holland,	36,531	35·98	8,115
Italy,	129,310	24·74	20,000
Russia,	3,788,197	21·00	497,341
Poland,	97,802	34·62	21,167
Caucasia,	450,268	15·30	43,041
Ireland,	46,158	34·92	10,073

FLAX GROWN IN IRELAND.

	Acres under Flax.	Yield per Acre. Stones.	Tons.
1895	95,202	21·80	12,972
1896	72,253	24·02	10,844
1897	45,576	23·93	6,818
1898	34,489	29·14	6,281
1899	34,989	30·83	6,743
1900	47,451	31·96	9,479
1901	55,442	36·93	12,797
1902	49,742	35·30	10,975
1903	44,685	28·87	8,064
1904	44,293	29·15	8,069
Average	52,412	28·40	9,304
1905	46,158	34 92	10,073

IMPORTS AND EXPORTS OF FLAX, IRELAND.

	Irish Production. Tons.	Imports. Tons.	Exports. Tons	Net Supply. Tons.
1895	12,972	35,506	5,253	43,225
1896	10,844	36,650	4,565	42,929
1897	6,818	37,715	4,446	40,087
1898	6,281	34,440	3,634	37,087
1899	6,743	40,145	3,438	43,450
1900	9,479	31,563	3,789	37,253
1901	12,797	28,785	3,839	37,743
1902	10,975	29,727	4,129	36,573
1903	8,064	38,168	3,487	42,745
1904	8,069	33,024	3,446	37,647
Average	9,304	34,572	4,002	39,874
1905	10,073	40,063	2,771	47,365

A Short History of Flax Spinning.

Having given an idea of the manner in which flax is cultivated and treated before coming to us, I can hardly refrain from giving a few particulars of the history of the art of spinning. We have proof of the antiquity of the art of spinning and the appliances used from the representations on the tombs of Egypt. These sculptured representations are of women spinning with the spindle and distaff, and are of a very ancient date, stretching back to the days of Moses, and even beyond. There can be little doubt that when the children of Israel were resident in Egypt they acquired some of the proficiency in the art of spinning for which the Egyptians were distinguished: for they had scarcely left Egypt when we are told (Ex. xxxv. 25) that "all the women that were wise-hearted did spin with their hands, and brought that which they had spun, both of blue, and of purple, and of scarlet, and fine linen, to adorn the tabernacle in the wilderness." When Pharaoh wished to honour Joseph "he took his ring from off his hand, and put it upon Joseph's hand, and arrayed him in vestures of fine linen" (Gen. xli. 42). The spindle and distaff spread all over the world, and were found with almost all people; yet simple as the spindle and distaff were, some tribes never made the discovery, but continued twisting fibres by rolling them between the palm and thigh. At the discoveries of the Lake dwellings in Switzerland, in 1865, spindles to the number of about forty were discovered that must have been at least 3000 years old. As to the time of the introduction of the spinning-wheel we have evidence from a manuscript in the British Museum of its invention about the beginning of the 14th century. In it a woman is represented standing and moving the wheel with the right hand. Two centuries later, 1533, the wheel at which the spinner sat and turned with her

foot was said to have been invented by a citizen of Brunswick. This was a great advance; but improvements continued to be made on it from time to time, and the greatest was the discovery of the two-handed wheel, which enabled the spinner to spin two threads at once, made about the year 1764. Notwithstanding the great superiority of this wheel over all previous methods, the spindle and distaff continued in common use in these countries down to the beginning of this century, and even to recent years. Mr E. B. Taylor, in his "Early History of Mankind" (1865), says that a few years ago a woman was seen by a friend of his in the Island of Islay spinning flax with a spindle, which was simply a bit of stick with a potato stuck on the end of it.

The first mill for spinning flax by machinery was erected at Darlington, in the county of Durham. In the year 1787 John Kendrew, optician, and Thomas Ponthouse, clockmaker, encouraged by the successful spinning of cotton by machinery, applied for a patent for the spinning of flax, hemp, tow, and wool, which they obtained, and immediately thereafter a mill was erected by them. The first spinning mill erected in Scotland (for flax) was at Brighton, near Glamis, in the year 1790. The first in Ireland was at Cork, some ten years later. About the same time two small mills were erected in the county of Antrim, one near Ballymena and one at Crumlin. In 1829 the first movement was made to introduce flax spinning by steam power in the capital of Ulster.

The art of spinning by machinery has been brought almost to perfection: the old-fashioned ways of our grandmothers are fast disappearing; if indeed they are not entirely things of the past. We have now enormous mills, spinning, in some cases, as much yarn per day as would go round the world two, three, or four times, with a regularity in size and evenness which is beyond the powers of the spinning-wheel, not to speak of the spindle and distaff, with labour comparatively nothing to the many hours of hand-work formerly required to do

what is now looked upon as a trifle. Yet, with all our improvements in flax machinery, we are not able to surpass, if indeed we can equal, the spinning feats of the ancient Egyptians. A corslet of linen, presented by Amasis, king of Egypt, to the Lacedemonians, was ornamented with numerous figures of animals worked in gold. Each thread of the corslet "was worthy," the ancient historian Herodotus tells us, "of admiration; for, though very fine, every one was composed of 360 other threads, all distinct." "The spinning," he adds, "was so marvellously fine that one similar was dedicated to Minerva at Rhodes, and fragments of it were long preserved as an example of exceeding cunning workmanship." Sir Gardiner Wilkinson tells of some linen taken from mummies being to the touch comparable to silk, and not inferior in texture to our finest cambric. One specimen had 540 threads or 270 double threads in the warp, and the limited proportion of 110 in the weft, to the inch, equal to the amazing fineness of 475 porters, or $95^{\underline{00}}$ in the warp and $38^{\underline{00}}$ in the weft. Mr Warden says, "The very finest cambric or linen of the present day looks coarse beside these specimens of the Egyptian looms in the days of the Pharaohs; indeed, so fine and beautiful were they that it is wonderful how the yarn could have been produced or a fine enough reed found for weaving them through." The greatest feat in spinning fine yarn in modern days by hand was accomplished by a girl in County Down, Ireland. In the year 1815, Catherine Woods, of Dunmore, near Ballynahinch, County Down, about thirteen years of age, spun a hank of linen yarn of 12 cuts, each cut 120 threads of $2\frac{1}{2}$ yard reel, which weighed 10 grains = 700 hanks per 1 lb. avoirdupois, which equals 8400 leas or cuts per lb. For this extraordinary and perhaps unequalled feat a premium of fifteen guineas was awarded by the Linen Board of Ireland. The finest yarn practically spun by machinery is 400 leas, although a small sample for exhibition of 800 leas per lb. has been spun; and to fully appreciate Kate Woods' performance, it is worth noting that $17\frac{1}{2}$ lbs.

of yarn such as she spun would contain a thread more than equal to the circumference of the earth. The Egyptians were the great manufacturing people of the ancient world. They occupied in this respect a position similar to our own in modern times; and let us hope that, unlike them, we may continue to rank first.

We close this Introduction with tables from the Belfast Linen Trade Report, and from the Secretary of Belfast Flax Supply Association, showing the number of spindles in the different flax-spinning countries, imports, exports, &c., also comparative prices of yarns and cloth at various dates.

SPINDLES IN DIFFERENT COUNTRIES.

Ireland,	1905	851,388
Scotland,	1905	160,085
England and Wales,	1905	49,941
Austria-Hungary,	1903	280,414
Belgium,	1902	280,000
France,	1902	455,838
Germany,	1902	295,796
Holland,	1896	8,000
Russia,	1902	300,000
Italy,	1902	77,000

POWER LOOMS IN DIFFERENT COUNTRIES.

Ireland,	1905	34,498
Scotland,	1905	17,185
England and Wales,	1905	4,424
Austria-Hungary,	1895	3,357
Belgium,	1900	3,400
Germany,	1895	7,557
Holland,	1891	1,200
France,	1891	18,083
Russia,	1889	7,312
Italy,	1902	3,500
Sweden,	1884	286
Norway,	1880	120
Spain,	1876	1,000

NUMBER OF SPINNING SPINDLES ON FLAX, HEMP, AND JUTE IN THE UNITED KINGDOM IN THE YEAR 1905.

	Flax Spinning Spindles.	Hemp Spinning Spindles.	Jute Spinning Spindles.
England,	38,660	25,123	3,448
Scotland,	160,085	1,534	257,040
Ireland,	812,952	7,090	3,450
	1,011,697	33,747	263,938

IMPORTS AND EXPORTS OF FLAX, DRESSED AND UNDRESSED, AND TOW OR CODILLA, INTO AND FROM THE UNITED KINGDOM.

IMPORTS.

FROM	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
	Tons	Tons.	Tons.	Tons	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Belgium, ...	22,270	20,715	16,777	15,562	14,280	17,756	20,226	20,495	21,571	23,086
France, ...	819	917	718	855	839	916	1,721	763	503	532
Germany, ...	1,443	947	1,064	1,209	1,950	738	335	400	960	665
Netherlands, .	2,754	2,660	2,782	2,659	2,681	2,593	3,462	3,470	3,834	3,408
Russia, ...	67,227	73,379	75,814	78,337	51,321	52,081	46,580	68,471	47,083	61,627
Other Countries,. .	686	184	98	430	505	1,481	1,096	1,102	966	780
Total Quantity,	95,199	98,802	97,253	99,052	71,576	75,565	73,420	94,701	74,917	90,098
Do. Value,.... £	3,117.316	3.203,184	2,932 646	2,927,864	2,511.810	3,070,000	2 944,390	3,675.664	3,185,475	3,581,808

EXPORTS.

TO	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
	Tons.	Tons	Tons	Tons.	Tons.	Tons	Tons	Tons.	Tons	Tons.
Belgium, ...	179	91	90	28	85	132	142	240	425	411
France, .	57	105	503	222	70	120	77	2	51	43
United States, . . .	4,645	5,020	3,272	3,792	3,510	4,372	6,801	5,071	4,645	2,742
Other Countries,. .	859	1,202	1,170	1,080	552	672	752	875	646	855
Total Quantity,	5,740	6,418	5,035	5,122	4,217	5,296	7,772	6,188	5,767	4,051
Do. Value, ..£	215,098	275,443	220,451	225,709	199,946	264,394	347,084	311,636	322,809	209,174

Imports of Flax, Tow, and Codilla to United Kingdom from 1896 to 1905.

	Into United Kingdom.	Into Dundee.	Into Six Scottish Ports—Dundee, Arbroath, Montrose, Aberdeen, Kirkcaldy, and Leith.
	Tons.	Tons	Tons.
1896	76,099	21,717	48,256
1897	80,188	20,962	52,343
1898	82,069	24,747	55,948
1899	80,979	21,514	52,643
1900	58,442	12,734	35,411
1901	75,565	18,583	41,151
1902	73,420	15,417	36,550
1903	94,701	20,231	49,684
1904	74,917	14,854	36,786
1905	90,098	18,103	39,374

Exportation of Linen Yarns (in Lbs.) and Manufactures (in Yds.) from the United Kingdom from 1896 to 1905.

	Linen Yarns	Linen Manufactures		Linen Yarns	Linen Manufactures.
	Lbs	Yards		Lbs.	Yards
1896	18,462,300	174,208,000	1901	12,971,100	150,215 300
1897	18,365,900	164,583,400	1902	14,370,000	163,128,600
1898	17,355,400	148,001,600	1903	14,090,400	154,946,900
1899	18,152,400	174,279,000	1904	14,750,500	161,763,200
1900	16,347,100	154,708,200	1905	14,694,300	183,445,900

Average Price of Yarns per Bundle in Ireland, Ordinary Line Weft No. 100.

1893.	4/1½	1897.	3/1½	1901.	4/-	1904.	3/9
1894.	3/6	1898.	3/1½	1902.	4/4½	1905.	4/1½
1895.	3/-	1899.	3/4½	1903.	4/1½	1906.	5/3
1896.	3/1½	1900.	4/3				

COMPARATIVE PRICES OF FLAX, &c., YARNS, AND CLOTH, AT VARIOUS DATES.

	Cotton.		Flax, Tow, and Jute					Yarns (1st Quality)						Cloth.
	Surat in London.	American Upland in Liverpool	Pernau D.	Riga K.	Archangel 3rd Crown Flax	Archangel No 1 Tow	Medium Jute 1st Marks	No 10 Flax Warp	No 24 Flax	No 30 Flax.	No 16 Tow Warp.	No 10 Tow Warp.	Good Jute, 8 Lbs	10½ oz. Jute Hessians
31st Dec. 1906	$3\frac{3}{4}$	$5\frac{13}{16}$	29·10	25·10	42	32	27·0	2/–	1/8¼	1/7½	1/9½	2/1½	2/11½	3¼
31st " 1905	$4\frac{7}{8}$	$6\frac{3}{8}$	33	28	44	34	19 5	1/10¾	1/6½	1/5½	1/7½	2/1	1/10¾	$2\frac{4}{17}$
31st " 1904 ..	$3\frac{11}{16}$	$3\frac{3}{4}$	32	26	43	40	16·0	1/10	1/7¼	1/7¼	1/10½	2/3	1/6¼	$1\frac{15}{16}$
31st " 1903	$5\frac{11}{16}$	$7\frac{3}{4}$	38	32	48	36	13 0	1/9¼	1/5½	1/5½	1/7½	2/1½	1/4½	$1\frac{10}{12}$
31st " 1902	4	$4\frac{13}{16}$	28	23	48	36	13 10	1/9¼	1/6	1/5¾	1/7¼	2/0½	1/4¾	$1\frac{13}{24}$
31st " 1901 .	$3\frac{13}{16}$	$4\frac{9}{16}$	30	23	47	35	11·15	1/9	1/7¼	1/6¾	1/7	2/0½	1/3¼	$1\frac{3}{4}$
31st " 1900 .	$4\frac{5}{16}$	$5\frac{1}{2}$	34	31	47	31	12·15	2/–	1/6½	1/6½	1/5½	1/10¼	1/7¼	$2\frac{1}{24}$
31st " 1899 .	$3\frac{7}{8}$	$4\frac{7}{16}$	27	22	31	25	14·5	1/4½	1/2½	1/2½	1/3¼	1/7½	1/6	$2\frac{7}{48}$
31st " 1898 ...	$2\frac{11}{16}$	$3\frac{3}{32}$	22	14·15	30	25	12·10	1/3¾	1/1½	1/1	1/3½	1/7¾	1/2½	$1\frac{35}{48}$
31st " 1897 .	$2\frac{13}{16}$	$3\frac{1}{4}$	22·10	15 15	31·10	25	10·0	1/4	1/1¼	1/1	1/4¼	1/8	1/2	$1\frac{27}{48}$

HACKLING.

THE process through which flax first passes in a spinning mill is called hackling. Describing the various processes in this department is comparatively simple: the great difficulty consists in describing the exact manner in which the various flaxes should be treated, their variety is so great, and the different purposes for which the different and also the same sorts are afterwards used. When we consider, not only the number of different countries from which we are supplied, but the different qualities in each, it will be easily understood that nothing short of a long practical training will enable any one to decide as to the way in which any particular lot of flax should be treated, or the yarn it would best suit, especially if a large variety of numbers are being spun.

In connection with mills in Ireland, where the flax is bought as a rule direct from the farmers, each separate lot is ticketed, and the prices entered on being warehoused, with remarks as to whether they are suitable for prime warp, ordinary warp, or weft; and this, with the price paid, if judiciously bought, coupled with the current prices of the season in which any particular lot is bought, is a guide to the manager to get at the particular class of flax he may want for any particular purpose. At the same time it must be distinctly understood that each lot of flax must be closely examined independent entirely of cost, and the particular yarn for which it is best adapted being determined, the treatment in hackling can then be accordingly regulated. Flax suitable for warp medium numbers may cost the same as flax for fine wefts, &c. The same remarks apply to Continental flaxes, where these are bought in the same way, from the grower or dealer, as the case

may be. In every concern we may presume that a system is adopted for carrying out this separation of lots, and further keeping the results of each distinct all through this department, until at the end the cost for the various numbers or sorts is obtained. It would be impossible for us to give the correct system to be adopted, for in various places we will find excellent systems, although differing considerably in detail, any one of which would possibly not work efficiently in any other concern, the reason for this being, that the matured method has grown with the place, which may have been originally small, and many of the details arisen from peculiar varieties in their situation, &c., &c.

Roughing.—In Ireland we may safely say all flax undergoes the process known as "roughing." We will suppose the flax has passed from the rough flax store to the roughing department. We will afterwards refer to the Scotch mode of treatment. Irish flax, especially mill-scutched, is, as a rule, so carelessly handled by farmers and scutchers, that, if for no other purpose than squaring the flax, it would require to go through some process for this purpose before going to the machines. In "roughing," the flax is divided into pieces of a certain size—this being regulated according to the description of flax. The "squaring" is first accomplished by the "rougher," who has a hackle before him, and by placing the root end of the flax in the hackle, and holding the piece at the opposite or "crop" end, then pulling the piece out, the fibres that were loose and straggling are left in the hackle, which are taken out and placed evenly on the piece—this operation being termed "dropping"—further "squaring" being done by the hand. In some places both ends are "dropped." The piece is then drawn across the hackle and opened up, lumps, knots, and any coarse tow which may have been left in the ends being removed. As each end is finished on the hackle, the loose straggling fibres still left are broken off by means of a "touch pin." A lap is now put on the piece so as to keep these separate in forming

a bundle, which is now passed on to the machine room. In the machine room skill and practical experience are required to hackle the different flaxes with the machines best adapted with gradation and number of hackles, and to regulate the speeds of sheets and head.

In Scotland, where the trade is principally dry spinning, and the numbers consequently heavy, 24 lea (2 lbs.) being practically the finest number spun, "roughing" the flax before machining is seldom adopted. For the higher marks of Riga and Pernau we think this a very great mistake, as spinners suffer far more through loss of yield than would repay "roughing," and have line not so evenly cut as it would be if it were put on the machines after "roughing." In the better marks of Archangel Rjeff, and similar flaxes, the omission of "roughing" is not so seriously felt, as the flax is generally even and tidy. Coarser flaxes are not worth the expense of "roughing." When "roughing" is too expensive, "stacking" is sometimes adopted. This consists of piecing the flax in double pieces, which means the size intended for a holder, "sqaring" slightly, opening on the hackle, and breaking the root end. This operation is gone through very rapidly, and boys can be trained to it, when the expense comes to be little more than piecing at the machine without any preparation.

We now give particulars of five machines which take in the range of flaxes used.

It is not found practicable to make machines longer than the first one given in the following tables, and also to have steady motion; so that, for such fine flax as cut line Courtrai for 300 lea, two machines are sometimes coupled together, which can be easily accomplished. This is making a 16, 18, or 20 tooled machine. As the gradation of hackles is more gradual the fibres are more gently dealt with, and yield better results. We have also given particulars of a machine arranged in this way (No. 2). Slow speeds of sheets and heads are very essential for fine flax, especially Courtrai. A pair of machines working at the above speeds can be attended

to by two boys; and the results from slow driving will well repay the outlay for the extra machines necessary as compared with quick driving. To the machine No. 3 the same remarks apply as to No. 1 and No. 2 as regards slow driving; and, indeed, for flax suitable for 200 lea it might be found profitable to couple two machines together, and so allow easy gradation of hackles; but this is not done so often as for finer numbers, for which Nos. 1 and 2 machines are constructed. It will be observed that the first tool is coarser than Nos. 1 and 2; but, if the flax has been very well "roughed," finer might be substituted in this instance, and with two machines coupled together the finishing tool would be 35 to 40 or 45 pins per inch, according to quality of material.

The machine of which we give particulars in No. 4 is a stripper rod machine. In many cases a brush and doffer machine is used for this class of flax, and, if a stripper rod is adopted similar to one given, Mr George Horner, Clonard Foundry, Belfast, attaches a revolving brush to keep the pins clean and free from gum. The brush revolves alternately slower and quicker than the surface speed of the hackles—when going quicker it cleans the rear side, and when slower, the front or cutting side of the pins; and by thus arranging the speed of the brush the hackles strip it of any tow that may accumulate.

We also give particulars of machines Nos. 5 and 6, for Russian flaxes. Such are used principally where coarse numbers are spun.

In Scotland the common practice of driving the machines at exceptionally high rates of speed is ruinous to the yield of dressed line, besides causing great wear and tear to the machines, and spinners would be very much cheaper in every way to have plenty of machines and drive slowly. The foregoing machines, in a general way, embrace those used for all classes of the different flaxes.

Intersection.—This should be arranged so that in all

cases the pins should be point to point. Closer intersection cannot possibly cut the fibre any better. The only exception to this would be: where the finishing hackle is very fine, it might be judicious to intersect $\frac{1}{16}$ in., as the flax might otherwise resist penetration. Neither is it right to open out the sheets at the coarse end, as this allows the centre of the piece of flax in the holder to pass unprepared to the finer hackles before being touched, thus "slaving" the flax unnecessarily. In order to cut more or less, the speeds of either the hackles or head, or both, should be altered.

Grouping.—The system of properly grouping the hackles is very imperfectly understood, especially in such places as work the coarser qualities of flax. In the coarser tools, this should be carefully looked after. It consists in so arranging the position of the pins in the stocks that the pins in each will strike a different part of the piece of flax in the holder. In order to accomplish this, the space between the pins should be divided into as many parts as there are hackles on the sheets, and the first pin on each hackle should commence with the division corresponding to the number of the hackle on the sheet. When a hackle is removed for repairs, one of the same "group"—or, in other words, with the pins in the same position—should be substituted.

Holders.—These should be kept in a proper state, substituting new ones when the edges turn up or otherwise become defective.

The india-rubber and flannel used should also be renewed when either shows that it has lost its holding properties. Defective holders allow the flax to be drawn out by the hackles.

Nos. 1 and 2.

Brush and Doffer Machine for Fine Cut Line Courtrai Flax.

Hackles to cut for 300 Lea.

Tools.	Holders.	No. of Bars.	Length of Pins.	No. of Rows.	Speed of Sheet.	Speed of Head.	Size of Piece.
11	10″	27 or 30	1″	2	9	3	14 per lb.

Pins per inch .. ½	1	2	4	7	11	16	23	31	40	50
No. of wire.....14	15	16	17	18	20	22	24	26	27	29

Pins per inch... ½	1	1½	2¼	3¼	5	7	9	12	15	18	22	26	30	34	39	44	50	For two machines coupled together for the same work
No. of wire.. .14	15	15	16	16	17	18	19	20	22	23	24	25	26	26	27	28	29	

No. 3.

Brush and Doffer Machine for Fine Long Line Courtrai and other Fine Belgian Flaxes.

Hackles to cut for 130 Lea to 200 Lea.

Tools.	Holders.	No. of Bars.	Length of Pins.	No. of Rows.	Speed of Sheet.	Speed of Head.	Size of Piece.
11	10″	27 or 30	1″	2	9	3	8 per lb.

Pins per inch.. ⅜	¾	1¼	2	4	7	11	16	22	29	37
No of wire.. 14	15	16	17	18	19	21	23	24	25	26

No. 4.

Stripper Rod Machine for Fine Irish and Medium Courtrai.

Hackles to cut for 80 Lea to 130 Lea.

Tools.	Holders.	No. of Bars	Length of Pin.	No of Rows	Speed of Sheet.	Speed of Head.	Size of Piece.
9	$10\frac{1}{2}''$	28	$1''$	2	12	4	7 per lb.

Pins per inch. .	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$	3	6	10	14	19	24
No. of wire.....	14	15	16	17	18	20	21	23	24

No. 5.

Stripper Rod Machine for Fine Russian and Coarse Irish Flaxes.

No. of Tools.	Length of Holders.	No of Bars.	Length of Pin.	No of Rows.	Speed of Sheet.	Speed of Head.	Size of Piece.
9	$10\frac{1}{2}''$	24	$1\frac{1}{4}''$	2	12	4	7 per lb.

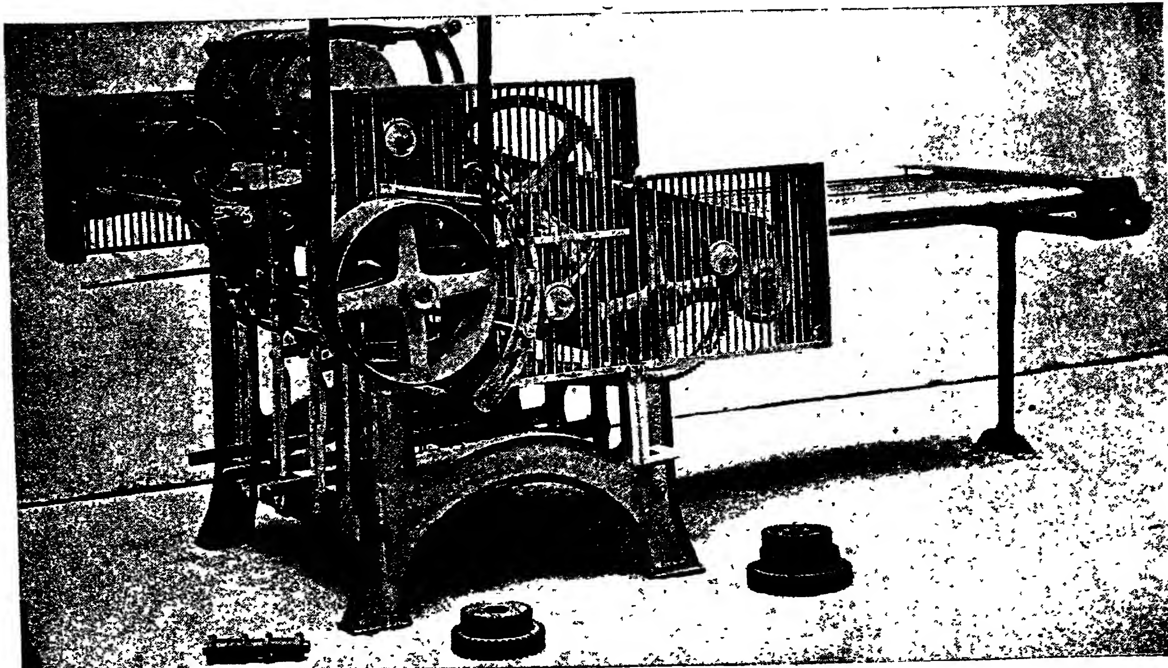
Pins per inch ..	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	3	6	10	14
No. of wire.. ..	14	15	16	17	18	19	21	22	22

No. 6.

Stripper Rod Machine for Coarse Russian Flaxes.

No. of Tools.	Length of Holders.	No. of Bars.	Length of Pin.	No of Rows.	Speed of Sheet.	Speed of Head	Size of Piece.
8	$12''$	20	$1\frac{1}{4}''$	2	12	$4\frac{1}{2}$	4 per lb.

Pins per inch...	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$	4	6
No. of wire.. .	10	12	14	15	15	16	17	18



FLAX SPREADBOARD.

FLAX PREPARING.

For Wet Spinning or Light Numbers.

In the spinning of yarns the first process after leaving the hackling is "preparing." In "preparing," the great object aimed at, in obtaining a rove suitable to be reduced to the size or lea required, is uniformity combined with the least possible change in the flax after it is received from the hackling. Three different machines—spreader, drawing and roving frames (one spreader, three drawing frames, and one roving frame)—generally form a "system," and what is termed a "system" are those frames over which the flax for any yarn passes before going to the spinning room. The spreader is in some places, and even by some machine makers, called the first drawing (which it really is), but for the sake of simplicity we have adhered to the name formerly and still commonly used. The first duties of an overseer are to learn the various calculations required. The principal one of these is the draft calculation. We would not be able to double without draft or drawing, and doubling is the means by which we obtain equality in the size of our yarn. Thus, a certain number—eight or ten cans—from the spread-board are put over the first drawing and united in one in the front, and a certain number of these are put over the second drawing and united in one, and so with the third drawing frame, so that we would have the sliver a great deal heavier at the end than it was when first spread. Instead of this, however, we want it smaller, and thus have draft or drawing. This is accomplished by the delivery roller going faster than the retaining roller in each of the frames; the greater the difference in their speeds and diameters the greater the draft.

In order to understand or to take the draft on a frame, you must first be able to take the speed of any particular

part, and understand the relation of drivers and driven wheels.

SPEEDS.

[The speed of the shaft is, say, 130; the circumference of the drum, 45 in.; and the pulley circumference, 39 in. You reqrire to multiply 130 by 45 and divide by 39; $\frac{130 \times 45}{39} = 150$, which is the speed of the pulleys. In the first place, you have 130, the speed of the shaft. Your drum is of 45 in. circumference, and every revolution makes the drum go through a space of 45 in., and would take 45 in. of belt in one revolution. If the pulleys were 45 in., the speed of them would then be the same. For example, the 45 in. of belt which the drum takes in one revolution would just take the pulleys round once, or go through 45 in. Again, if the pulleys were twice the circumference, say 90 in., then it would take the drum two revolutions to drive the pulley once; $\frac{130 \times 45}{90} = 65$, just half the speed of the shaft. Again, if the drum were 90 in. and the pulleys 45 in. every revolution would take the pulleys round twice; $\frac{130 \times 90}{45} = 260$] In the above example I have used the circumference in order to explain clearly, but as diameters always bear the same relation to one another as their circumference, they are used instead. In gearing, the same principle holds good, multiplying and dividing by the teeth in the wheels. It is evident that one wheel with forty teeth will drive one with twenty twice as quick, and one with ten four times as quick. Very little thought will teach the youngest this principle of drivers and driven.

To Find the Speed of the Drawing Roller.—Multiply the speed of the shaft by the diameter of the drum by pulley pinion, and divide by the diameter of the pulleys multiplied by the drawing roller wheel; $\frac{130 \times 16 \times 40}{80 \times 16} = 65$. You have here the speed of shaft 130, multiplied by the

two drivers, drum and pulley pinion, and divided by diameter of pulleys and drawing roller wheel, the two "drivens."

Drafting.

To take the Draft of a Drawing and Roving Frame.

Rule.—Multiply the number of teeth in the back shaft wheel by stud wheel by retaining roller wheel by diameter of drawing roller, for a dividend. For a divisor, multiply drawing roller wheel by the pinion on the other end of back shaft by teeth in stud pinion by diameter of retaining roller.

Example.—Drawing roller wheel 46, back shaft wheel (generally the change wheel) 48, pinion on other end of back shaft 18, stud wheel 46, stud pinion 24, retaining roller wheel 72, diameter of drawing roller 3, diameter of retaining roller 2.

$$\frac{48 \times 46 \times 72 \times 3}{46 \times 18 \times 24 \times 2} = 12$$

Instead of working these questions by multiplying all the top numbers together and dividing by all the bottom ones multiplied together, the much more simple mode of cancelling may be adopted. This is done by reducing the size and quantity of the numbers, by dividing any number on the top and one in the bottom line by the same figure called a common divisor. Thus, in the foregoing, in the lower line, 46 will divide equally once into the first number 46, and once into 46 on the top line leaving one. The second number can be divided by 18 leaving 1, and into 72 on the top line leaving 4. The third figure divided by itself leaves 1, and into 48 on the top line leaves 2. The fourth figure divided by itself leaves 1, and into the 2 above 48 leaves 1. Thus we have: $\frac{1 \times 1 \times 4 \times 3}{1 \times 1 \times 1 \times 1} = 12$ draft.

Reason of Draft Rule.—Draft depends on the relative speed and diameters of the rollers. If the drawing and retaining rollers were the same size and went at the same speed, then we should have no draft. If the

rollers were the same size, and the drawing roller went twice as quick as the retaining roller, then we should have 2 of a draft; or, if they went the same speed, and the drawing roller was twice as large, then again we should have 2 of a draft. Let us first find the relative speeds. Taking the speed of the drawing roller at 1, and proceeding on the principle of drivers and driven, we have for the drivers: drawing-roller wheel 46, multiplied by pinion on end of back shaft 18, multiplied by stud pinion 24, and divided by drivens; back shaft wheel 48, stud wheel 46, and retaining-roller wheel 72, thus: $\frac{1 \times 46 \times 18 \times 24}{48 \times 46 \times 72} = \frac{1}{8}$; this gives us the speed of retaining roller one-eight of speed of drawing roller, and the roller being 3 in. and retaining roller 2 in., the retaining roller will only take in $\frac{2}{3}$ of what the drawing roller delivers, and going $\frac{1}{8}$ of the speed, we have $\frac{1}{8} \times \frac{2}{3} = \frac{1}{12}$, the relative surface speed of the retaining roller to the drawing roller. In other words, the drawing roller delivers twelve times as much as the retaining roller takes in. Instead of placing the drivers as a dividend, and thus obtaining a fraction as $\frac{1}{12}$, we use them as the divisor, and obtain a whole number, and hence the number of inches more delivered by the drawing roller in a given time than taken in by the retaining roller, as in the rule and example. If you take the speed of your drawing roller actually, or a supposed speed, you may proceed as directed above, and not have a fraction; thus, with roller supposed speed 80:

$$\frac{80 \times 46 \times 18 \times 24}{48 \times 46 \times 72} = 10, \text{ speed of retaining roller.}$$

Multiplying the circumference of the rollers by their speeds gives the respective quantities taken in and delivered, or by their diameter gives the same proportionate results:

80×3 in. $= 240$ in. delivered by drawing roller.
10×2 in. $= 20$ in. taken in by retaining roller.
$\frac{240}{20} = 12$ in., being the number of inches delivered for every inch taken in.

The draft of a spreading table is taken in the same way, with sometimes the introduction of two more wheels, an intermediate stud and stud pinion, and in some drawing frames this will be found also. Placing the driver and driven pinion respectively with the drivers and driven, as given in preceding drawing frame draft calculation, we proceed as indicated in it.

Standing Numbers.

Frames made by different makers are sometimes differently arranged, the change pinion being on the drawing roller or the back shaft. Leaving out the change pinion, which may be either the one or the other in the draft calculation, gives us the standing number. In the foregoing we supposed the back shaft wheel to be the change pinion, and by dividing the draft obtained, 12 into 48, the change pinion, we obtain a standing number: $\frac{48}{12} = 4$ standing number. Multiplying the draft required by this number gives the change pinion required.

Example.—Supposing we want a draft of 14, then $4 \times 14 = 56$, the change pinion required. We can also find the draft by dividing the change pinion by the standing number.

If the change pinion is on the drawing roller, by omitting it in the draft calculation already given we find the standing number; but instead of multiplying the draft by the standing number, as in the previous case, we divide the draft into this standing number for the change pinion required: $\frac{48 \times 46 \times 72 \times 3}{18 \times 24 \times 2} = 552$ standing number.

It will be noticed that to lengthen the draft we must either increase the back shaft wheel or diminish the front roller wheel, and *vice versa*.

Sett Weight.—The most important and frequently oc-

curring calculation is that in regard to the weight which the flax must be spread in order to bring out a certain weight of rove. If you are given the spinning draft instead, and know the lea required, you can find what weight the rove should be (see "Spinning"). There are two systems of making any weight of rove required, one by what is known as the sett weight, and the other the clock system. I will first explain the mode by sett weight. For this system you have a bell attached to the delivery roller of your spread-board, which rings after a certain number of yards is delivered, say from 300 to 1000 yards; the cans are removed when the bell rings, and thus each contains the same length. What is wanted is the total quantity which will be required to be put up in one sett together, to run into one sliver at the front of the first drawing frame. Now, it does not matter so much whether you have your sett in few or many slivers. Suppose a sett to produce a rove 20 drs. per 100 yards is 100 lbs., you may have this weight in ten cans with 10 lbs. each, or in eight cans with 12½ lbs. each, &c.

Rule to find sett Weight.—Multiply the length of bell by drafts of first, second, and third drawing frames, roving and spinning, and divide by 300, being yards in a cut, multiplied by lease of yarn, multiplied by doublings or ends into 1 on second drawing, multiplied by ends into 1 on third drawing.

Example.—Suppose length of bell to be 500 yards.
Yarn required, 50 leas.
Drafts on 1st, 2d, and 3d, drawings and roving, 12
Spinning draft, 10
Slivers into 1, on 2d, drawing, 12
Do. 3d, do., 6

$$\frac{500 \times 12 \times 12 \times 12 \times 12 \times 10}{300 \times 50 \times 12 \times 4} = 144 \text{ lbs.}$$

Now, in order to thoroughly understand the sett weight, let me explain the reason of this rule. As a dividend on the top line, we have, in the first place, 500 yards, which is the length that 6, 8, or more slivers are each to

be delivered from the spreadboard. The 500 yards, going through the first drawing with 12 of a draft, is made, of course, twelve times its former length $(500 \times 12) = 6000$ yards. And so, in the second and third drawing and roving, it is drawn out twelve more times in each case, and on the spinning ten times; so that, by multiplying the length you commence with by the drafts it encounters, you have the length of yarn in the 500 yards you started with—$500 \times 12 \times 12 \times 12 \times 12 \times 10 = 103{,}680{,}000$. But, although we have 6000 yards at the first drawing, owing to having twelve ends at the back of the second drawing, instead of running our 6000 yards through and having twelve times as much, we must also divide it by 12, the doublings; and having 4 doublings or slivers into 1 on third drawing, we must divide by four also. This gives us two of the items, 12 and 4, used as a divisor; and by dividing (12×4) 48 into $103{,}680{,}000 = 2{,}160{,}000$, we have the number of yards which our 500 yards sliver would be drawn into. Now, as we want 50 lea yarn, and know that 300 yards are in a lea or cut, and 50 lea yarn means 50 leas or cuts to 1 pound weight, we have 50 cuts multiplied by 300 yards, the length of a cut $(50 \times 300) = 15{,}000$ yards to 1 pound weight. Having the number of yards, 2,160,000, which you will have of yarn, and the number of yards required in 1 lb. weight, 15,000, then by dividing, $\frac{2{,}160{,}000}{15{,}000} = 144$ lbs., you get the number of lbs. which must be in this length of yarn, and, as this length was only 500 yards delivered from the spreadboard, you have 144 lbs. in your sett. As the 144 lbs are doubled into one sliver after going over the first drawing, you can put this quantity in any number of cans without altering the weight of yarn, the number used depending on various circumstances. If there are ten cans of slivers, you have $14\frac{4}{10}$ lbs. in each can of 500 yards; if eight cans, 18 lbs., and so on. By the foregoing it will be seen that any spinning draft, or, in other words, any weight of rove, can be obtained for any lea. If you know the drafts of preparing, length of bell, and doublings, just substitute any lea required with the

draft for that lea required in the rule given. If this ended the finding of the sett weight we should say it was a very simple calculation, but overseers who have tried it, not only for the first or second time, but perhaps for years, get disgusted at their rove coming out different from what they wanted. I speak of the rove coming out different, because overseers test the weight of 100 or 200 yards to see if they are right, and sometimes the weight of the sliver as it progresses, but I will speak of this afterwards. Now, the reason of this difference depends mainly on three things, the varying waste on the material, bulking of the sliver, and contraction by twist in spinning. There is great difficulty in forming a guide, and overseers must find by experience what to add or take from their sett weight owing to these causes. A close approximate can be formed of the first cause, namely, the amount of waste, which depends on the material, and we would guard overseers against the mistake of allowing too heavy a percentage where Baltic or light flax is used. Although in Baltic flax you may have a larger quantity of waste in bulk, still the heavy dust or waste which falls from flax such as good Irish, Dutch, &c., counterbalances the quantity from the other, and we have tried experiments leading to the above results in a good many cases. The second cause, namely, bulking, may be explained as follows: Placing one sliver on the feed roller increases its diameter, consequently the second or top sliver is taken in quicker, owing to this increase, which shortens it, so to speak, and makes it heavier. If you take the average weight of 100 yards of sliver at the back of a drawing frame, say with 12 ends at the back being run into 1 in front and 12 draft on, then the 100 yards in front should weigh the same as that at the back, because, as we have explained already, although the 100 yards are multiplied by 12, still the weight is divided by draft 12 as well; but you will find that it weighs heavier in heavy slivers, although it loses by waste, and more especially if you have the 12 ends in 6 slivers, that is two in

each. The heavier your slivers the greater the bulking, and if very light there will be little or none. Let us take, for example, the sett we have just done, and it is generally found that you require on the gross weight very little, say 1 or 2 per cent. less. Having practically found this, we divide it in this way—

10 per cent additional for waste.
8 per cent. less for contraction by twist.
3 per cent. less by bulking.
11 per cent. less.
10 per cent. additional.
1 per cent. less.

In the majority of cases, however, you will find that for a rove 16 to 17 drs. per 100 yards you require neither addition nor deduction with ordinary doublings. Then, for 17½ drs., as the bulking increases, say 2 per cent. less, and for 19 drs. 4 per cent. less. Then, in 24 to 28 drs., for, say, 25's to 20's, with same doublings, 8 to 10 per cent. less. In these heavier roves, the bulking increases in greater proportion than waste, &c., and contraction gets less, consequently you have more to take off. In finding a lighter rove than 16 drs., the bulking and waste diminishes; being for lighter yarn, requiring more twist, the contraction increases. And in 80's, with say 13 drs., owing to these causes you will have to take off from 4 to 6 per cent. You have now little more than the waste and contraction to contend with. If your waste is about 6 per cent., and you deduct 10 per cent. for contraction, that will equal 4 per cent. to be deducted, and so on. I give this as data from which overseers may form an idea of how they are to act, and the things they have to study, and not by any means as hard and fast rules. Another and simpler method is to find sett weight from weight of 100 yards of rove. I will first give the rule to find weight of 100 yards of rove from required lea and spinning draft. Having the lea and draft required in

spinning to find the weight that 100 yards rove would require to be spun, is as follows:—

Rule.—Multiply the spinning draft required by 80, and divide by the lea required.

Example.—Required the weight of 100 yards of rove for 50 lea with 10 spinning draft—

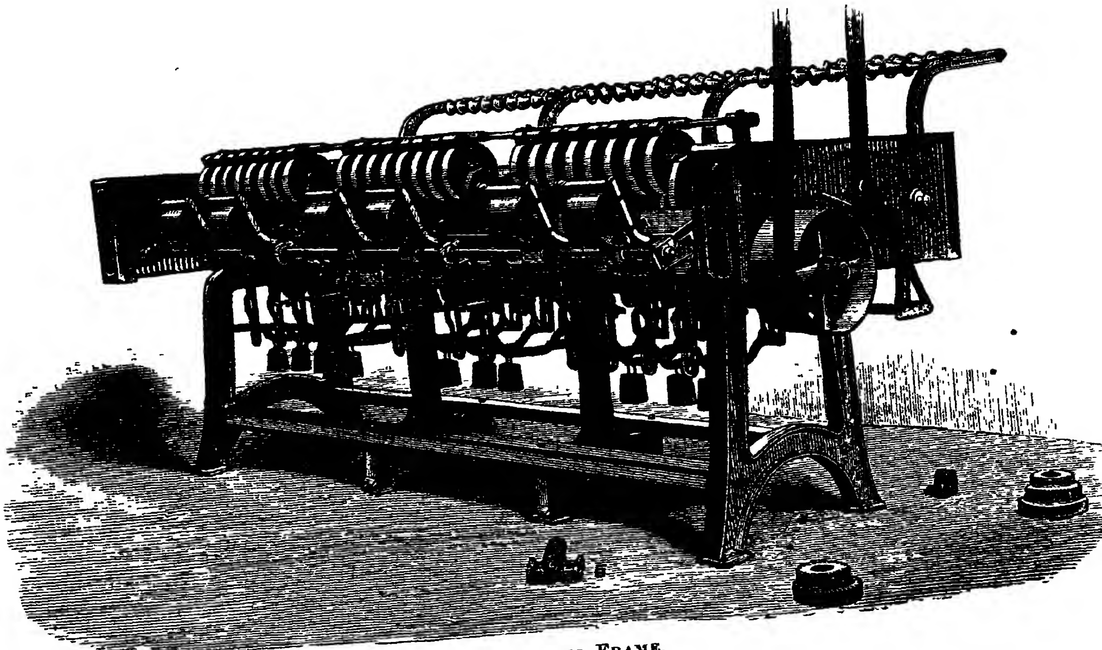
$$\frac{10 \times 80}{50} = 16 \text{ drs.}$$

By ordinary calculation this 16 drs. will give less than a draft of 10, but the above rule is with 7 per cent. added for contraction by twist, and brings 16 drs. to give a draft of 10. It is a handy rule, and quite near enough for preparing overseers. To find the weight per 100 yards of rove without allowance for contraction by twist, multiply by 85·3 instead of 80. In a good many places. instead of weighing 100 yards of rove, the number of yards per ounce is found, and from this the spinning draft. In connection with this there is another handy rule, namely, twice the lea in yards per ounce gives 9·38 of a draft for that lea, without any allowance, however, being made for twist. Thus for 20 lea we would require 40 yards of rove per ounce to give us a draft of 9·38 in the spinning. Similarly 50 lea requires 100 yards per ounce for 9·38 draft, &c. From this we can find by proportion the number of yards in an ounce for any draft. Thus, if 40 yards per ounce for 20 lea gives us 9·38 draft, what number of yards per ounce will give us a draft of 8?

$$8 : 9{\cdot}38 :: 40 = 46 \text{ yards per ounce.*}$$

Rule to find Sett Weight from Weight of 100 *yards of Rove.*—Multiply weight required of 100 yards of rove by drafts on roving, first, second, and third drawings, and divide by doublings on third and second drawings, and as the answer will be the number of drs in 100 yards, divide by 16 for ounces and 16 for lbs, and multiply by length of bell, and divide by 100. Taking the same system and particulars as the last, we have

*For further notes on these rules see "Spinning."



Drawing Frame.

ten of a draft for fifty lea, which, according to the rule previously given, equals

$$\frac{10 \times 80}{50} = 16 \text{ drs.}$$

$$\frac{16 \times 12 \times 12 \times 12 \times 12 \times 500}{4 \times 12 \times 16 \times 16 \times 100} = 135 \text{ lbs.}$$

Having only 135 lbs., we require to take into consideration bulking and waste. Now, by allowing 10 per cent. for waste, and 3 per cent. less for bulking—that is $10 - 3 = 7$ per cent. additional—we have about the same thing, 135 lbs. + 7 per cent. = 144 lbs. The explanation of the rule is this: Having sixteen drs. of rôve per 100 yards, and having twelve of a draft on the roving, it will be twelve times heavier at the back of the roving or front of third drawing; and, for the same reason, twelve times heavier at the back of the third drawing, but, there being four ends, one of them is only one-fourth the weight, and hence we divide by four. Then, at the back of the second drawing, it is twelve times heavier, but, there being twelve ends, one is only one-twelfth for the same reason, and so we divide again by twelve. This brings us to the front of the first drawing, and, there being twelve of a draft, we multiply again by twelve, which gives us the total weight of our sett. Thus we have so far the weight of rove per 100 yards multiplied by the drafts on the roving, third, second, and first drawing frames. and divided by doublings on third and second drawings. This would give us the weight in drs., and so we must divide by sixteen to bring it to ounces, and sixteen to lbs., which is dividing by 256. This now leaves us with the weight for 100 yards, so we have to multiply by the length of bell and divide by 100.

Weighing of Cans.—As the sliver is weighed in the cans, all the cans must be of uniform weight. In some places weighing is done by a beam and weights, and in this case a weight equal to the empty can is placed permanently on the opposite side from the can, and so we obtain just the weight of sliver in the can. In other places a spring balance is adopted, and in this

case the weight of the number of cans must be added to the sett. In starting a system you are not sure what length of a bell you may need. You can certainly make more or less cans in the sett, and so in this way get your cans to hold it, but it is simpler to suppose your bell at 100 yards. If this gives you 48 lbs., and you are anxious to have twelve cans, that equals 4 lbs. per can, and if your can holds 20 lbs., that takes $\frac{20}{4} = 5$ times as long a bell, or 500 yards.

Common method of calculating Setts.—I think, in almost every place, that, unless in starting a system where you have no data to commence with, the easier and more practical method of finding the sett by proportion is adopted. Supposing you have a sett weighing 300 lbs., cans included (great care must be taken by the novice, if he weighs by balance, to deduct the weight of his cans), and each empty can weighs 15 lbs., and ten cans, then you must deduct $10 \times 15 = 150$, which equals $300 - 150 = 150$ lbs. sliver, and giving, say, 16 drs. per 100 yards over a certain system; if you want 14 drs. you require less weight, and consequently $16 : 14 :: 150$, answer $131\frac{1}{4}$ lbs. Of course you must take into consideration here, as in the sett, the various causes which affect the sliver, and if you just adhere to the proportion without making any allowance for heavier or lighter slivers, less or more waste, especially where the difference is great, it will be sure to come out different from your intended proportion.

Testing correctness of Sett.—If overseers are anxious about their setts turning out right, and being sure that there is no blunder, they will be glad to test them before finally converting into rove, and this may be done by multiplying the weight of rove wanted by the roving draft for weight of 100 yards of sliver at the back of the roving, and again by draft on third drawing, and divide by doublings on the same, for weight of 100 yards at the back of third drawing, or as delivered from second drawing, and so on. If the sliver is not what it ought to be in weight,

you have a remedy by altering your drafts for the time, bringing it on correctly the next time. This of course applies to starting a new system only, as mistakes so great are never made over a system that we are repeatedly changing. Supposing your rove ought to weigh 16 drs. and draft on roving 12, 100 yards of sliver at back of roving should equal 192 drs. or 12 oz. Supposing, on weighing your sliver, you find it weighs 216 drs., this would give you $\frac{216}{12}$ = 18 drs per 100 yards rove, then, if 12 draft gives you 18 drs., what draft will give you 16? As 116 : 118 : : 12; ans. 13·5 roving draft to bring out the rove wanted.

Bell Motion.—As the length of bell comes so often into the sett weight, we require to know how to find it. There is just the circumference of the delivering boss, the wheel which the worm on the end of it drives, and the bell wheel.

Rule.—Multiply the circumference of the boss in inches by the number of teeth in each wheel, and divide by 36 for yards.

Example.—Diameter of boss 4 in., pinion driven by worm on end of delivering boss roller 48, and bell wheel 36.

$$\frac{48 \times 36 \times 12{\cdot}56}{36} = 602{\cdot}8 \text{ yards.}$$

On reeling this, we will find two or three yards short, caused by the delivering boss going faster than the drawing roller, which we shall explain afterwards, and this leaves us, say, about 600 yards.

Starting a System.

The first thing to settle is the speeds of the various frames. First determine at what speed you intend running your roving frame spindles, which is generally the data from which we start in flax preparing. The speed at which the spindles are driven varies greatly in different places. In a roving suitable

for 50 lea, with an 8 in. × 4 in. rove bobbin, they are now run from 500 to 600 revolutions per minute, depending to a certain extent on the twist, which if little would, with a high speed, drive the fallers too fast, and in line they seldom exceed 140 per minute; for a roving of this description 600 revolutions of spindles, with 130 fallers per minute, is the greatest speed which should be used. Suppose you intend running them 314 revolutions, and the average twist which you intend having on is ·5, this means a half turn for every inch delivered, so $\frac{314}{\frac{1}{2}} = 628$ inches delivered by roving. Diameter of roller, say = 2 in., then circumference $(2 \times 3{\cdot}1416) = 6{\cdot}28$, which is the quantity delivered by one revolution, but requiring 628 inches, therefore $\frac{628}{6{\cdot}28} = 100$ revolutions of the front roller of roving.

The inches to be delivered, multiplied by the number of spindles and divided by the draft, equals the length at the back of roving, $\frac{628 \times 72}{12} = 3768$ in. required. Supposing six deliveries on the third drawing, one requires to deliver $\frac{3768}{6} = 628$ inches. The diameter of drawing roller is, say $2\frac{1}{8}$ in., the circumference $(2\frac{1}{8} \times 3{\cdot}1416) = 6{\cdot}67$ and $\frac{628}{6{\cdot}67} = 94$ revolutions of third drawing roller, but we must take off a percentage for stoppages by doffing, &c., say 20 per cent. and $94 - 20$ per cent. $= 75$ speed of third drawing roller. Speed of third drawing roller being 75 and diameter $2\frac{1}{8}, = 2\frac{1}{8} \times 3{\cdot}1416$ circumference $= 6{\cdot}67$, and $75 \times 6{\cdot}67 =$ quantity at front, divide by draft, and multiply again by number of ends at back, say, 24, this gives quantity required at back of third drawing, or front of second drawing: thus, $\frac{75 \times 6{\cdot}67 \times 24}{12} = 1000$ in., with two deliveries. Roller requires to deliver $\frac{1000}{2} = 500$ in. The drawing roller being, diameter $2\frac{1}{8}$, circumference

$= 2\frac{1}{2} \times 3{\cdot}1416 = 7{\cdot}85$, and $\frac{500}{7{\cdot}85} = 64$, which would be the speed of the roller. Now, as the stoppage with the second drawing about equals that of the third, it will be better to run the second a little quicker than 64, say 70, the speed of the second drawing roller. The speed of second drawing roller being 70, and circumference 7·85, draft 12, and ends at back 24, we have, as in third drawing, $\frac{90 \times 7{\cdot}85 \times 24}{12} = 1000$ in., to be delivered at the front of first drawing, having two deliveries, $\frac{1000}{2} = 500$ in., by the roller. Diameter of first drawing roller 3 in., circumference $3 \times 3{\cdot}1416 = 9{\cdot}42$, $\frac{500}{9{\cdot}42} = 53$, speed of drawing roller; but, as the stoppages here, owing to changing of setts, running off sizes, &c. &c., are greater than any of the other two, we would require to run it at about 60 revolutions. The speed of the spreadboards varies exceedingly, depending greatly on the draft. With a long draft the front roller runs faster than with a short draft, and so, if one spreader is not sufficient with the draft and number of cans you find best adapted, two spreaders are used, and sometimes three spreaders to two systems.

Changing the length of Bell, the sett changes by proportion.—Having 500 yards with 150 lb. sett changing to 1000 yards bell; thus, 500 : 1000 : : 150; answer, 300 lbs., with bell 1000 yards. The same thing holds good in changing draft on any of your frames. If with 150 lbs. you change from 12 draft to 10 draft on any frame, 12 : 10 : : 150; answer, 125 lbs. sett. Each overseer should have beside him a small table for each system, showing for the different weights of rove the setts required, so that he has simply to look up the table for the sett required. On the following page is given a table showing the quantity of flax required for a certain number of bundles of yarn, with and without addition for waste. Overseers will be able to judge what percentage requires to be added, according to the material, &c. &c.

Table Showing Flax Required for 100 Bundles of Yarn.

Leas.	Weight in lbs. per Spindle.	Weight in lbs per Bundle.	Weight per 100 Bundles	100 Bdls Flax wasting 10 per cent.	100 Bdls. Flax wasting 12 per cent.	100 Bdls. Flax wasting 14 per cent	100 Bdls Flax wasting 15 per cent	100 Bdls. Flax wasting 18 per cent	100 Bdls Flax wasting 20 per cent
12	4	16 66	1666 66	1851 84	1893·92	1937·97	1960 78	2032·44	2083 32
14	3 42	14 28	1428 53	1587·25	1623·32	1661·08	1680 68	1742 11	1785·66
16	3	12·5	1250	1388·88	1420·44	1453 48	1470·58	1524·39	1562·50
18	2·66	11·11	1111·11	1234·56	1262 62	1291 99	1307·01	1355 01	1388 88
20	2·4	10	1000	1111·11	1136·35	1162 79	1176 47	1219·51	1250
22	2·18	9·09	909·09	1010·10	1033·85	1057 08	1069 51	1108·64	1136·36
24	2	8 33	833 33	925·92	946 95	968 99	980 38	1016·25	1041·66
25	1 92	8	800	888.88	909·08	930 23	941·17	975 61	1000
28	1·71	7·14	714 28	793·64	811·54	830 55	840 32	871·07	892·85
30	1·6	6·66	666·66	740·73	757 56	775·19	784 30	813	833 33
32	1·5	6 25	625	694·44	710 22	726·74	735 29	762·19	781·25
35	1·37	5 71	571·43	634 92	649 34	664·47	672·23	696·86	714 28
40	1·2	5	500	555·55	568·17	581 39	588·23	609·75	625
45	1 066	4·44	444·44	493 82	505·04	516 79	522 87	542	555 55
50	·96	4	400	444 44	454 54	465·11	470·58	487·80	500
55	·872	3·63	363 63	404 03	413·20	422·82	427 80	443 45	454·54
60	·8	3·33	333·33	370·36	378·78	387 56	392·15	406·50	416 66
65	·738	3 07	307·69	341·18	349·64	357 8	361·98	375 23	384 61
70	·685	2·85	285 55	317·61	324 35	332 03	335·94	348 23	356 93
75	·64	2 66	266·66	296 28	303·02	310 07	313·71	325·19	333 33
80	·6	2·5	250	277 77	284 08	291·86	294·11	304·87	312·50
85	·564	2 35	235 29	261·43	267 37	273·43	276·81	286 94	294·11
90	·533	2 22	222·22	246 91	252 52	258 39	261·41	271	277·77
95	·505	2 10	210·52	233 91	239 21	244 79	247·67	256 73	263·15
100	·48	2	200	222 22	227 27	232 56	235 29	243·90	250
110	·436	1·81	181·81	202 01	206·50	211 41	213 88	221·72	227·26
120	·4	1·66	166·66	185 17	189 38	193·72	196 07	203·24	208·33
130	·369	1·53	153·84	170 93	174·81	178·88	180 99	187·61	192 30
140	·342	1·42	142·85	158 72	162 32	166·04	168 05	174·21	178·56
150	·32	1·33	133 33	148·14	151·51	155 03	156 86	162·59	166·66
160	·3	1·25	125	138·88	142·04	145·35	147·06	152·44	156·25
170	·282	1·17	117·64	130·71	133·67	136·79	138·40	143·46	147·05
180	·266	1·11	111·11	123·45	126·26	129·19	130 71	135·50	138 88
190	·252	1·05	105 26	128 06	119·61	122·39	123·83	128·36	131·57
200	·24	1	100	111·11	113 63	116 28	117·64	121 95	125

TABLE SHOWING TOW REQUIRED FOR 100 BUNDLES OF YARN.

Leas.	Weight in lbs. per Spindle	Weight of 100 Bundles.	100 Bdls. Tow wasting 22 per cent.	100 Bdls Tow wasting 25 per cent.	100 Bdls. Tow wasting 28 per cent	100 Bdls. Tow wasting 30 per cent	100 Bdls Tow wasting 33⅓ per cent	100 Bdls Tow wasting 35 per cent	100 Bdls. Tow wasting 40 per cent.
8	6	2500	3205·13	3333·33	3472 22	3571·42	3750	3846 15	4166 66
10	4·8	2000	2564·10	2666 66	2777·77	2857·14	3000	3076·92	3333 33
12	4	1666·66	2136 74	2222·22	2314 8	2380 94	2499 99	2548·71	3777·77
14	3·42	1428·53	1831 45	1904 70	1984 06	2040 75	2142 79	2197·69	2380 88
16	3	1250	1602·56	1666 66	1736·11	1785 71	1875	1923·07	2083·33
18	2·66	1111·11	1424 50	1481 48	1542·08	1587 3	1666·66	1709 04	1851 85
20	2 4	1000	1282 05	1333·33	1388 88	1428 57	1500	1538·46	1666 66
22	2·18	909·09	1152·56	1212·12	1262 51	1298 70	1363 63	1398 46	1515 15
24	2	833 33	1168 37	1111 11	1157 39	1190·47	1249 99	1282	1388 88
25	1·92	800	1025 64	1066 66	1111 11	1142·87	1200	1230·77	1333 33
28	1 71	714·28	915 74	952 37	992 05	1020 40	1071·42	1098 89	1190·46
30	1 6	666·66	854 69	888 88	925·91	952 37	999·99	1025·63	1111·11
32	1·5	625	801 28	833 33	868 05	892·87	937·50	961·54	1041 66
35	1 37	571 43	732 56	761 90	793 65	816·32	857·14	879·07	952 38
40	1·2	500	641 02	666 66	694·44	714 28	750	769·23	833·33
45	1 066	444·44	569 74	592 59	617·27	634·91	666 66	683 83	740 73
48	1	416 66	534 18	555 55	578 69	595 22	624 99	641·01	694·43
50	·96	400	512·82	533·33	555 55	571·42	600	615 38	666 66
55	·872	363·63	466·19	484·84	505 04	519·47	545 44	559 43	606·03
60	·8	333·33	427 34	444 44	462 95	476·18	499·99	512 81	555 55
65	·738	307·69	394 35	410 25	427·34	439 55	461 53	473 21	512 81
70	·685	285 55	366 09	380 73	396 59	407 92	428 27	439·31	475 91
75	·64	266·66	341 87	355 55	370·36	380 94	399 99	410 24	444 44
80	·6	250	320 51	333·33	347·22	357·14	375	384 61	416 66
85	·564	235·29	301 65	313·72	326 79	336 12	352 93	361 98	392·15
90	·533	222 22	204 87	296 29	308 64	317·45	333 33	341·87	370·36
95	·505	210 52	269·9	280·69	292·38	300·74	315·78	323·67	350·86
100	·48	200	256·41	266 66	277·77	285·71	300	307·69	333 33

In the foregoing tables it will be seen that the amounts are not obtained by simply adding the different percentages of waste, and we refer the reader to page 110 for rule of obtaining amounts in this table, and reason of same.

General Working.

In the preface to this work I explained that I would be unable to go minutely into the working, but would merely give a few hints which may be useful to young overseers.

Spreading.—This is the first process the flax goes through after being hackled. Every one knows that in spreading properly depends greatly the ultimate evenness of the yarn, and hence a great deal of attention is paid to it. The pieces having been divided into the size required, and laid so as to form continuous lines—4 or 6, as the case may be—are drawn through the fallers in the spreadboard, and doubled into one continuous line or sliver. Now, it is easily seen how much depends on the manner in which this spreading is conducted. If the sliver is not right here you may afterwards lessen, but cannot entirely overcome, the evil. Spreading tables of 4 or 6 slivers are used, depending on various circumstances, but generally 6-line spreaders are used. Some advocate 4-line under some circumstances for heavy numbers; this is for the purpose of giving the girl more time, or to drive quicker, having only two slivers instead of three to spread. This may do best where you require, owing to the quantity, to drive a 6-line spreader too fast, and consequently prevent the spreaders from taking due care. But it will be patent to any one that six slivers going into one will, if properly cared for, make a more even sliver than four. In some other cases the 4-line may serve best, for example, where we have very short, poor flax, and require to overlap greatly, that is, to put the end of one piece very near the top of the preceding one. If you

use a 6-line spreader for this you require to keep the end of each piece further from the preceding one, otherwise you would have too heavy a sliver, and the tendency would be for the ends to readily break away, owing to the drawing roller having drawn one piece before the end of the next comes up, in consequence of its being too far back and the flax being short. It may be here said, Make the pieces smaller; but, although a skilful spreader may divide fine dressed line into a great number of parts, still line for coarse canvas numbers (ordinary pieces) does not divide into more than two, or at the outside three, parts without getting tossed. Very commonly three spreadboards for two systems, or what is also common, two spreadboards for each system, are used. Ends dropping away are a source of constant annoyance all through preparing, causing waste; and if the part is not broken off which is minus an end, the consequence is uneven yarn, and overseers should strive to lessen the causes of this evil. In preparing for wet spinning, such a thing as stretching the piece of flax is rarely done, and should as far as possible be avoided. The cure for this is short drafts; however, in such cases as spreading ends, it can hardly be avoided. It is not to be supposed that stretching will improve the flax under any condition, although in some cases it may draw better and cause less ends to fall at the front Our aim should be to keep the flax as near as possible to what it is on coming from the hands of the sorters; and short drafts are the only remedy for the ends dropping in such cases. With a long draft the piece is more liable to be pulled clean away, owing to the shortness of the flax, before the end of the next piece comes up to the rollers. It may be said, If we shorten the draft, of course we will have to spread lighter, which places the top of each piece further away from that of the preceding one, and consequently, although the draft is less, the end of next piece is longer in coming up; but the simple remedy is, make the pieces spread smaller, and overlap as close as before. Stretching is sometimes practised by bad spreaders, for the purpose

of making the pieces carry more easily into the fallers. This should be done by forming with the fingers of the right or left hand a hollow, and encircling the end of the pieces already on the board, tapering the piece laid down to the end so as to fit into the hollow formed in the next piece. The distance which the end of each piece is from the preceding one depends greatly on the length of the flax and draft. Formerly very long drafts were put on spreadboards in coarse numbers, where the material was not very strong, even running as high as 40; now, however, masters see it to be advantageous to put far less drafts on and increase the spreading power, drafts going as low as 15, 12, &c. These short drafts are more essential in low numbers, say up to 20's in wefts and medium warps, as the flax is not so well cut nor so strong as in the higher numbers, hence the easier we can use it the better. On the drawing and roving the lowest generally worked with is 12. and this may be taken as data, say, up to 40's or 50's, or, in other words, as the material gets stronger it will stand more pulling, but weaker material, such as Baltic, Pernau, and poor Irish, will not. It is an object to have drafts as long as the material allows, so as to increase doubling; and in short drafts it is best to stop at that point where the advantage gained by shortening the draft is counterbalanced by causing less doubling.

Causes of Bad Work.—The many things which cause bad work in a preparing room, and so affect the yarn detrimentally, are, as in any other branch of spinning, almost innumerable. I shall endeavour to give only a few.

Gills overburdened is one of the most easily seen, and one of the worst evils in a preparing room. Nothing can be worse than a gill wanting in capacity, that is length of pin and width, where the sliver is jammed up with no freedom for action of fibres. This is almost always accompanied by running over the top of the gill, and nothing when drawing causes more uneven

or worse looking yarn. The gill varies with the weight of sliver or lea to be made, but varies also according to the material and the way in which it is hackled. Light, fozy material, lightly hackled, requires an open gill. With too close a gill choking is the result. At the same time, it is advantageous to have as close a gill as can be practically wrought with. Too coarse or open a gill allows the sliver to be drawn in layers, so to speak. A coarse fibre will not do with a fine gill, choking, breaking of pins, &c., being the result.

Speed of Delivering Boss.—In the machinery now made the speeds of the different parts are so correctly proportioned that little attention is at first required to the speed of the delivering boss; but after repair such as the re-turning of the drawing roller, the delivery boss which is driven from it should be altered in speed. The turn off from the delivery boss should not be exactly the same as the drawing roller. The delivery boss has to deliver just the same quantity as the drawing roller, but, in order to keep the sliver tight and and in proper order between the two, the boss is driven a shade quicker. Generally it is driven so that it will deliver from 2 to 4 per cent. more in length than it receives, and consequently keeps the sliver at a nice easy tension. The danger is not in driving the delivery boss too slow, for in that case your slivers would get slack and compel you to set it right, but in driving the delivery boss too quick. Let me illustrate this by a little bit of experience. A tow system, on which was generally wrought light wefts, was changed on to a warp yarn with exactly the same sett and a little allowance for less waste, and of course the same weight of rove was expected, but, instead, it came out a good deal heavier, and when the weaker material went on immediately after, down the rove came, and on examining the frames (for we were convinced that something was wrong besides any little difference the waste might make), we

found the delivery boss of the third drawing going a good deal too quick, the result being that the weak material was drawn and yielded, whereas the stronger material did not yield, or at least so much.

Rule to find Relative Delivery of Boss and Drawing Rollers.—Multiply the circumference of the drawing roller by its speed for delivery of drawing roller. Then multiply the speed of the drawing roller by the pinion on the end of the drawing roller, which is a driver, and divide by the pinion on the end of the delivering boss, which is a driven; this gives you the speed of the delivering boss, and the speed multiplied by its circumference equals its delivery.

Example.—Circumference of drawing roller 10, speed of roller 50, pinion on end of drawing roller 64, pinion on end of delivery boss 50, circumference of boss 8.

$10 \times 50 = 500$ delivery of drawing roller

$\dfrac{50 \times 64 \times 8}{50} = 512$ do. boss roller

Excess of boss roller over drawing roller equals $2\frac{1}{2}$ in. per 100 in.

If the selvedge is rough and broken, it has a tendency to ruffle and cause slubs; and again, if too thick, it dints the roller, thus making it draw imperfectly, and necessitating constant sliding or cleaning up. While on this subject, it may be mentioned that wood is best for making pressing rollers. Although in Scotland a great number of metal rollers covered with leather are used, on the score of cheapness, yet their unsuitableness for flax and tow more than counterbalances any advantage gained by their being less costly. From preparing for flax and tow spinning we may discard them entirely, though we will have to refer to them again in preparing for jute spinning. Rollers must be carefully made so as to cover the conductor, without being so broad as to cause them to become hollow in the centre and stand high on the sides. We have now, however, a new conductor, invented and patented by Messrs Combe, Barbour, & Combe, which is self-adjusting to the roller. Well-seasoned wood is essential—say alder three years cut.

Rubbers.—Rubbers in conjunction with the rollers should be a constant care to the worker, and should be kept strictly free from dust, &c., which is rubbed off the roller; for nothing looks worse in yarn, or is more provoking, than rubber lumps. Revolving rubbers are sometimes applied to drawing frames, but dead rubbers for the bottom of the drawing roller are cheaper and better by far; and, unless for fine warp yarns, dead rubbers are also preferable for pressing rollers. The flannel on rubbers should be kept in good order, as after a certain amount of wear they are worse than useless, collecting dirt and allowing it to pass in lumps.

Faller Cleaner.—Several inventions have recently been patented for the purpose of keeping the fallers clean. Of these we consider Andrews' Patent Faller Cleaner the most satisfactory, having for its object the cleaning of gills and fallers while in motion. It is placed underneath the bottom screw, and can be applied to the shortest or longest reached frames. The bottom or lower slides are cut in the centre, and a curved downward slide is added, occupying about five inches in the centre, the part of the slides before and behind this semicircular slide remaining, as before, horizontal. In order to push or drive the fallers round these semicircular slides revolving tappets are introduced, one at each end of the faller. These tappets are so arranged that a faller is received on the periphery of the tappet and carried round the curved slides to a point where the "heel" of the faller runs into a small recess. While in this position the point of the tappet runs underneath the front of the faller-head, and turns it upward, keeping it in position till the nipper, or projecting part of the tappet, lifts and restores the faller to its ordinary position in the bottom screw. In this way the fallers are taken out of the bottom screws and carried round on their side or flat, the pins pointing towards the drawing roller; while thus travelling on their sides, a revolving brush is

applied, thus removing all dirt and fibrous substances from the faller bars and gills. This invention is easily applied, and with it preparing machinery can be run for a very long period without the constant cleaning, which, with the ordinary slides, is necessary.

Speed of Fallers.—The speed of the fallers should be in accordance with the length of sliver taken in, or a little faster, in order to pin properly. If the fallers went slower, or even at the same speed as the number of inches delivered to them, the sliver would not be properly pinned, but would lap up. The proportion in which the fallers should travel quicker than the delivery to them depends on the weight and material in the sliver, the fallers going faster with a heavy sliver. In first drawing frames for heavy numbers this excess of faller speed should be about 3 per cent., and ranging from, say, 2 to 4 or 5 per cent. They must not be allowed, however, to run quicker than is necessary to pin properly, otherwise the too quick motion of the gills on the fallers would tend to make naps, &c. This may be easily checked by calculating the number of inches taken in by the back roller and the number of inches travelled by the fallers. The speed of the fallers is obtained by finding the speed of the screws and multiplying their speed by their pitch.

Rule.—Multiply the speed of the back shaft by the pinion driving the screw, and divide by pinion on end of screw, and then multiply by pitch of screw for the speed of fallers.

Example.—Supposing the speed of back shaft to be 50, pitch of screws $\frac{11}{16}$ths of an inch, pinion on back shaft driving screw 30, pinion on end of screw 20, we have

$$\frac{50 \times 30 \times \frac{11}{16}\ (\text{or } \cdot 687)}{20} = 51 \cdot 5 \text{ ins. travelled by fallers.}$$

Rule for Quantity delivered to Fallers by Retaining Roller.—Multiply speed of shaft by pinion on end of shaft, stud pinion, and circumference of retaining roller,

and divide by stud wheel multiplied by retaining roller wheel.

Example.—Speed of back shaft as before, 50, pinion on end of back shaft 18, stud wheel 44, stud pinion 28, retaining roller wheel 72, diameter of retaining roller 2 in.; thus we have

$$\frac{50 \times 18 \times 28 \times \overset{\text{Cir. of roller.}}{6{\cdot}28}}{44 \times 72} = 50 \text{ in. delivered by retaining roller to fallers.}$$

From these two speeds we have $51{\cdot}5 - 50 = 1{\cdot}5$ excess of faller speed. As this excess is for 50 in., we have thus 3 in. for 100, or 3 per cent.

Conductors.—Those at the front delivering boss should be set so as to suit the frame following, and to suit one another. If, for instance, you have a sliver going up at the back of a drawing frame which is too wide, in going through the back conductors the outer edge gets doubled over and twisted on the gills, and, of course, receives more severe usage, making too heavy a selvedge, and indenting the wooden pressing roller, whereas it should be delivered flat to the gills, and thus drawn even, with little breakage to the fibres, they being in the same line as on the previous frame.

Proper Position of Drawing Roller.—The position of the drawing roller in relation to the fallers is another essential feature. The surface being placed too high raises the sliver out of the gills, and again, if too low, draws the sliver down on the bottom of the gill, and besides not making good work, if strong, will cause improper drawing, choking, &c. Now, the drawing surface of the roller to be right should be placed about one-sixteenth above the bottom of the gills, to allow the sliver to go freely through the gills without raising the fibre above them. The roller should also be placed as close as possible to the fallers.

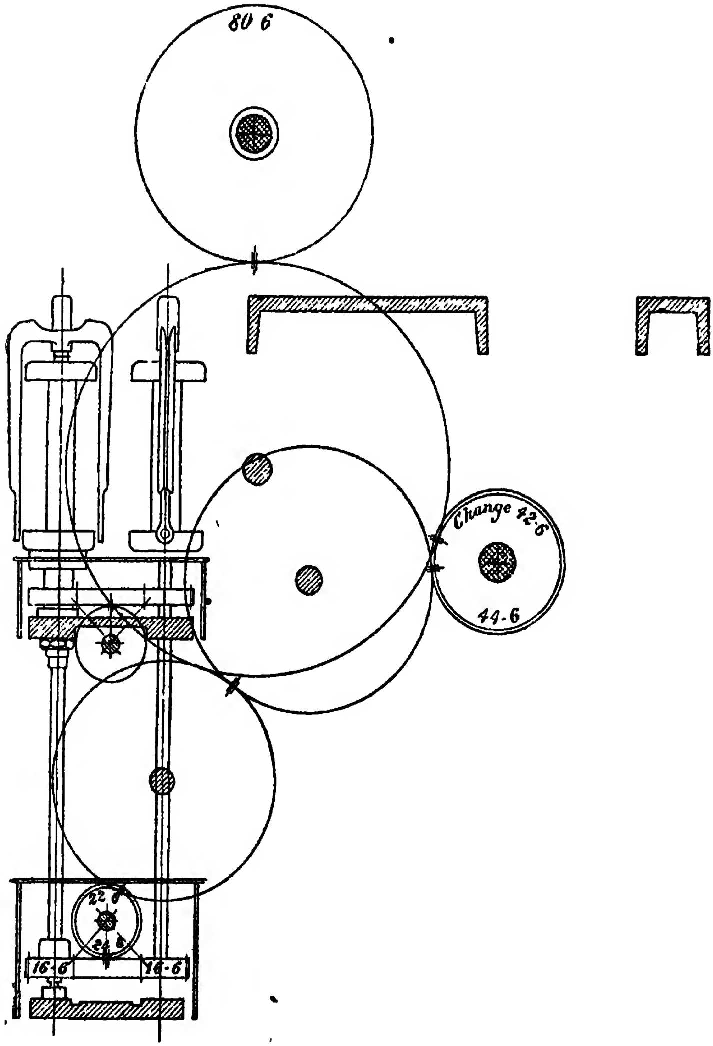
Roving.

The roving, next to the tow combing, is by far the most complicated machine, mechanically speaking, to deal with which we have in flax preparing, and, I might add, in the whole process of flax spinning.

In working the roving the same remarks apply as to the drawings; and as we here twist the sliver, which is then termed rove, and put it on bobbins, we have this extra part to consider. As we intend giving a short explanation of the bobbin motion, we will notice a few things not coming under this head. We have to know what amount of twist to put on a rove; and here we may give a very simple rule. If the sliver were not twisted it would not stay together to pass through the spinning trough to the rollers, and consequently we must put on sufficient twist to hold it together. Now, this is your guide, as twist serves no other purpose: put on just as much twist as will carry it through and no more. (See bad effects of hard twisting in spinning.) There is, practically speaking, no rule for the amount of twist on any given rove, as it depends on the strength and weight of material—the heavy and strong requiring less than the lighter and weaker—so that an overseer must just alter accordingly, and he can form a very good idea of what any rove requires from the weight and quality of the one preceding and the twist it required, and by making sure, after the first few rounds, whether he requires less or more.

Although it is not of the same practical use here as in spinning to an overseer, we give the rule for finding the actual amount of twist on a roving frame, and then for applying the amount decided on. We give a drawing of a flax spiral roving frame, made by Messrs Fairbairn, Naylor, Macpherson, & Co., Limited, Leeds, from which can be followed the various wheels and pinions incorporated in the calculations.

Rule.—Multiply the pulley pinion or wheel on driving shaft by the drawing roller wheel by pinion on the



FLAX SPIRAL ROVING FRAME.

spindle shaft, and divide by the twist pinion multiplied by the pinion on the end of the spindle shaft multiplied by the spindle pinion multiplied by circumference of drawing roller.

Example.—Pulley pinion 44, twist pinion 42, drawing roller wheel 80, pinion on end of spindle shaft 22, spindle pinion 16, circumference of drawing roller 7·85.

$$\frac{44 \times 80 \times 22}{42 \times 22 \times 16 \times 7{\cdot}85} = {\cdot}66 \text{ twist per inch.}$$

By leaving out the twist wheel in the foregoing calculation we obtain the twist standing number, and dividing twist required into this number obtain pinion required. Thus—

$$\frac{44 \times 80 \times 22}{22 \times 16 \times 7\ 85} = 28 \text{ twist standing number.}$$

If, however, our gearing is all on the same side of the frame, we have the following rule.

Rule.—Pinion on the spindle shaft multiplied by stud wheel and drawing roller wheel, and divided by pinion on the end of shaft multiplied by spindle pinion multiplied by twist wheel multiplied by circumference of drawing roller.

Example.—Pinion on the spindle shaft 24, pinion on end of spindle shaft 32, stud wheel 64, spindle pinion 18, drawing roller wheel 80, twist wheel 40, circumference of drawing roller 7·06. Leaving out the twist wheel, we have $\frac{24 \times 64 \times 80}{32 \times 18 \times 7{\cdot}06} = 30$ twist standing number.

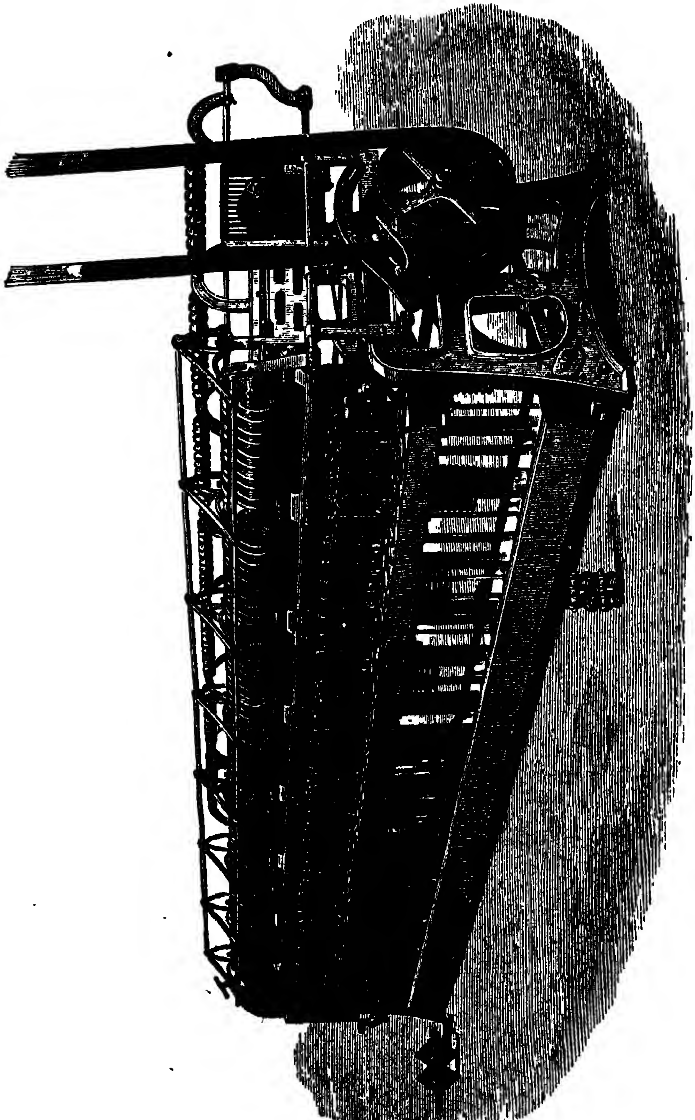
With twist required ·75, we have $\frac{30}{{\cdot}75} = 40$ twist wheel.

Differential Motion.

Unlike the manner in which the thread in the spinning-room is put on the bobbins, the rove requires to be put on without any stress or drag. Before this motion was applied to the roving frame, the rove was put on the bobbins by means of a drag, just as in spinning at the present time, and this necessitated a considerable amount of twist being put

on the rove, in order to bear the drag without breaking. As already shown, very little twist suffices, and hence this motion was introduced, which drives the bobbin at such a speed as just to take up the length delivered by the drawing roller without dragging the sliver coming down, or allowing it to become too slack and get caught by the flyers. Then as the bobbins increase in size this motion alters at every stage where their diameter becomes greater.

Relative Speed of the Rove Bobbin to its Circumference.—In order to understand the application of the differential motion to the bobbin, we must first thoroughly understand the reason for which it is required, and the variations it is required for. We will demonstrate the varying speed of the bobbin by an example. Take the speed of the drawing roller at 90 revolutions, the diameter of drawing roller at $2\frac{1}{2}$ in., and we have the circumference of drawing roller ($2\frac{1}{2}$ in. $\times 3{\cdot}1416) = 7{\cdot}85$, and the speed 90 multiplied by the circumference 7·85 equals the amount delivered per minute $(90 \times 7{\cdot}85) = 706$ inches per minute. Now, suppose the spindles are running at 400 revolutions per minute, and the circumference of the bobbin barrel at starting 3 in., by dividing the circumference 3 in. into the amount delivered, 706 in., it gives us the number of revolutions the spindle would require to put on the amount delivered, $\frac{706}{3} = 235$ revolutions. Now, if the bobbin went as quick as the flyer, none would be put on, so that the bobbin has to stand, as it were, every minute, while the flyer puts on 706 in., or has for its speed the speed of the spindle, 400 less 235, which equals 165, the speed of the bobbin at the start. Then, take the bobbin at the finish at, say, $3\frac{1}{2}$ in. diameter, circumference $= 11$ inches, and the quantity delivered, which is always the same, 706 inches divided by $11 = \frac{706}{11} = 64$, which is the number of revolutions now required to put on the amount delivered, so that the



ROVING FRAME.

bobbin will now run (400−64)=336 revolutions at the finish, and, as shown, 165 at the start.] It will thus be seen that we have to increase the speed of the bobbin as it fills, and this is done by diminishing the speed of the differential wheel. The differential motion is rather complicated, especially on first acquaintance. The wheel is not fixed to the shaft, but has two wheels which act as intermediates to convey the motion from a wheel on the shaft which intersects these wheels, and they intersect the socket, which is also loose on the shaft, and it conveys the motion to the bobbins. Now, if you stop the differential wheel, the same speed will be given to the socket wheel as the shaft; and, again, if you drive the differential wheel quick enough, the socket will stand, so that the quicker you drive the differential wheel the slower the socket is driven, and hence the bobbins are driven slower, as the bobbins receive their motion from the socket, and *vice versa*. One can best get acquainted with the various motions by freeing the pinion on the shaft, and having it, the differential wheel, and the socket wheel, free to move in any direction. In this way it may be seen, by holding the socket fast, that it takes two revolutions of the shaft pinion (which is now loose for experimenting) to cause the differential wheel to make one revolution. Again, if the differential wheel stood the socket would go at the same speed as the shaft, and according as the speed of the differential wheel increases in the same direction as the shaft the socket diminishes; and it has just been said that two revolutions of the shaft make the differential wheel revolve once, so that every revolution of the differential wheel gives the socket two revolutions less than the shaft. Thus if the differential wheel were driven 44 revolutions, the socket would go 88 revolutions less than the speed of the shaft. As explained, we require the bobbins to go quicker at the end than at the start, and consequently we must drive the differential wheel slower as the bobbin increases in diameter, remembering always the rule, that the quicker your differential wheel goes

the slower the bobbins go, and the slower the differential wheel the quicker the bobbins. We must thus have some means of varying the speed of the differential wheel, and this is accomplished in roving frames by three different appliances—the expansion pulleys, cone, and disc. All of these work on the same principle, and when the principle of one is understood, the working of the other two is easily followed.

Messrs Combe, Barbour, & Combe's Roving.

Expansion Pulleys.—In the roving frames of these makers we have applied the expansion pulleys. A calculation to find the diameter at which the pulleys must be when starting will give a very fair idea of their working; and having got this length, the subsequent movements can be easily explained. In order to do this, we must find the speed at which the bobbin should run at the start, as explained.

Supposing the speed of the shaft is 125, the drum 36 in., and the pulleys on the roving 18 in., then we have $\frac{125 \times 36}{18} = 250$ speed of roving.

We must now find the speed of the spindles, as explained before. Having 250 speed of roving shaft, 72 pinion on roving shaft, driving 45 on the end of spindle shaft, pinions on the spindle shaft 30, driving 20 on the spindle, this gives us $\frac{250 \times 72 \times 30}{45 \times 20} = 600$ $\left\{\text{speed of spindles.}\right.$

In order to find the speed of the drawing roller, we follow the roving shaft to the opposite end of the frame from the pulleys on which is the twist wheel, which we will suppose is 38, driving a 90 wheel on the drawing roller; this gives $\frac{250 \times 38}{90} = 105{\cdot}55$ $\left\{\text{speed of drawing roller.}\right.$

If the diameter of the drawing roller is $2\frac{1}{2}$ in., the circumference will equal 7·85 in., and this multiplied by the speed gives $105{\cdot}55 \times 7{\cdot}85 = 828$ inches delivered by the drawing roller. If the diameter of the bobbin is $1\frac{1}{4}$ inches, the circumference equals 3·92, and this divided

into the amount delivered by the drawing roller gives $\frac{828}{3\,92} = 211 \cdot 2$ as the number of revolutions required to be made by the spindle to put on the amount delivered. Therefore, the speed of the spindles being 600, we have $600 - 211 \cdot 2 = 388 \cdot 8$ speed of the bobbins at start. This being known, we have now to find at what diameter the expansion pulleys must be placed in order to give us the required speed, 388·8 revolutions.

Finding the Required Speed of the Differential Wheel, the Speed of the Bobbin being known.—Instead of taking the bobbin carrier as a driven, which it really is, let us suppose it a driver, and then follow the motion back. We have therefore the speed of the bobbin carrier (388 8) multiplied by 20, the number of teeth in the bobbin carrier, divided by 30, pinions on bobbin shaft, multiplied by 20, the pinion on the bobbin shaft, driving a pinion with 32 teeth, which has on the same stud a bevel pinion 25, which drives a bevel pinion 25 on the end of the shaft which runs to the socket, and on the opposite end of this shaft a pinion with 25 teeth drives a bevel pinion with 25 teeth, and on the same stud a wheel with 32 teeth drives another wheel with 32 teeth on the end of the socket. Taking out the drivers and driven, we have $\frac{388 \cdot 8 \times 20 \times 20 \times 25 \times 25 \times 32}{30 \times 32 \times 25 \times 25 \times 32} = 162$ speed of the socket.

The speed of the roving or pulley shaft is 250, and we require the socket to go only 162, then the socket requires to go $250 - 162 = 88$ revolutions less per minute than the shaft. As before explained, for every turn of the differential wheel the socket makes two turns less than the pulley shaft; so that by driving the differential wheel the one half of 88, which equals 44, the socket will be driven at the proper speed. The speed of the differential wheel thus requires to be 44.

Finding the Diameter of the Expansion Pulleys, having the Speed of the Differential Wheel.—Continuing in the

same way, we have the speed of differential wheel, 44, multiplied by the number of teeth in it, 96, divided by the pinion which drives it, 34, multiplied by the wheel on the same shaft, 86, divided by the pinion on the expansion pulley shaft, 20.

This gives $\frac{44 \times 96 \times 86}{34 \times 20} = 534.212$ speed the expansion pulley requires to be at the start.

The expansion pulleys are driven by a band from a grooved pulley on the drawing roller. Now, as we found before, the speed of the drawing roller is 105·55 revolutions, this pulley is $15\frac{1}{2}$ inches, and, having the speed at which the expansion pulleys are required, namely, 534·212, we can find the diameter required, $\frac{105\ 55 \times 15\ 5}{534 \cdot 21} = 3 \cdot 06$ or $3\frac{1}{16}$ inches diameter, which the expansion pulleys require to be at start, with the bobbin barrel $1\frac{1}{4}$ inches diameter. In the three different rovings there is no difference in this calculation, but only in the means applied to vary the speed of the differential wheel as the bobbin fills

It does not matter, therefore, which you take ; you proceed in the same manner thus far. The gearing may be different, and is different with the different makers, and at the same time there may be less wheels and pinions, the driving being more direct. Having followed the calculations giving the necessary diameters at which the pulleys must be started in order to accomplish the work required, any one following the calculations with the explanations given (which apply just the same to the other two) should form not only a correct idea of the various motions and their relations to one another, but be able also to take any calculation, and know the exact result which any alteration would involve. This is comparatively simple so far, but becomes more difficult as we follow the motion of the bobbin while filling.

Let us suppose our bobbin increases in diameter $\frac{1}{8}$ in. every row that is put on, and that our bobbin when full will be 4 in. diameter. Then we will require

$4 - 1\frac{1}{4} = 2\frac{6}{8} = 22$ eighths, and this requires twenty-two rows of rove, and consequently twenty-two traverses of the builder. As the diameter increases so does the bobbin speed increase, and for this reason the differential wheel must be driven slower. In order to drive the differential wheel slower we must drive the expansion pulleys slower Having got one row of rove on the bobbin, diameter will be $1\frac{3}{8}$ in.; substituting this diameter for $1\frac{1}{4}$ in in the calculation, we will find 3·366 the diameter of expansion pulleys when the bobbin is $1\frac{3}{8}$ in., and so we find the diameter at which the expansion pulleys must be as each successive row of rove is laid on, as indicated in the table below. Having the first result, it may be found in an easier way by proportion. If the bobbin when $1\frac{1}{4}$ in. diameter requires 3·06 in. diameter of expansion pulleys, what will it require when $1\frac{3}{8}$ in.?

$$1\tfrac{1}{4} : 1\tfrac{3}{8} :: 3{\cdot}06 = 3{\cdot}366 \text{ answer.}$$

Diameter of Bobbin.	Diameter of Expansion Pulleys	Diameter of Bobbin.	Diameter of Expansion Pulleys	Diameter of Bobbin.	Diameter of Expansion Pulleys.
$1\frac{1}{4}$	3 06	$2\frac{1}{8}$	5 202	3	7·344
$1\frac{3}{8}$	3·366	$2\frac{1}{4}$	5·508	$3\frac{1}{8}$	7·65
$1\frac{1}{2}$	3·672	$2\frac{3}{8}$	5 814	$3\frac{1}{4}$	7·956
$1\frac{5}{8}$	3·978	$2\frac{1}{2}$	6·120	$3\frac{3}{8}$	8 262
$1\frac{3}{4}$	4 284	$2\frac{5}{8}$	6·426	$3\frac{1}{2}$	8·568
$1\frac{7}{8}$	4 59	$2\frac{3}{4}$	6 732	$3\frac{5}{8}$	8·874
2	4·896	$3\frac{7}{8}$	7 038	$3\frac{3}{4}$	9 180
				$3\frac{7}{8}$	9·486

From the foregoing table we have got the diameter of the pulleys with each row of rove. The pulleys are increased in diameter by one side being made to intersect the other; the further they are intersected the larger their diameter becomes. This intersection is caused by the spindle from the moving side of the pulleys bearing against a bevel plate. At the start the spindle is bearing against the plate near the bottom. The plate is bevelled, the bottom being furthest away from the pulleys. At each rise and fall of the builder, or half tooth of the ratchet wheel, the expansion pulleys are

raised, and the spindle bearing against the bevelled plate is raised also and pushed in, causing a deeper intersection at each rise and fall of the builder. The expansion pulleys are generally made so that they increase 1¼ inch for every inch they are pushed in by the bevelled plate; or, in other words, they increase in diameter 1¼ inch for every inch of intersection. This, of course, depends on the angle which the intersecting sides make with the pulley spindle.

The plate against which the spindle from the pulleys rests, and which controls the intersection, is made with a bevel of one inch per inch of perpendicular, so that every inch which the expansion pulleys are raised the spindle is pushed in one inch, increasing the pulleys by intersection 1¼ inch in diameter. As already seen, we require the expansion pulleys at 3·06 in. diameter at the start, with 1¼ in. bobbin barrel, and placing our pulleys at this diameter, we require ·306 in. increase for each rise and fall of the builder, or for each row of rove that is put on in the example taken.

Placing a ratchet wheel of that pitch which will raise our expansion pulleys so that the bevelled plate will cause intersection equal to an increase of ·306 inches diameter, our bobbin will be driven at the required speed as each row is laid on. We may find exactly what amount we will require to increase ·306, by proportion. Thus: If one inch gives 1¼ inch increase what will give ·306? As 1·25 : ·306 :: 1 inch; ·245 answer.

The pulleys may be made to give a greater increase in diameter per inch of intersection, or the bevelled side of the plate, forming with its perpendicular one a greater angle, necessitating only a finer ratchet wheel, and *vice versa.*

To find the bevel which pulleys require to be to give any required increase in diameter for every inch of intersection, we may give a very simple method without entering into the relations of angles to one another.

Rule.—Draw a straight line, which we will call A B, erect a perpendicular at any point C, measure towards A the distance you mean to intersect, say one inch, erect at this point D another perpendicular. and on

it mark the distance from the line A B equal to the increase in diameter which you require the pulleys to make per inch of intersection, say 1¼ inch, then 1¼ inch from A B call E. From this point E on the second perpendicular draw a line to the point C on A B, from which the first perpendicular is drawn, and this gives one side of the expansion pulleys. Proceed in the same way on the other side of the first perpendicular, or, what is the same thing, draw a line having the same angle with A B as the line already formed, and this gives us the two inside or intersecting sides of the pulleys and the angle at which they require to be so as to increase 1¼ inch in diameter for every inch of intersection.

The angle required for one inch increase per inch of intersection = 45°. The angle required for 1¼ inch increase per inch of intersection = 51½°.

The expansion pulleys used by Messrs Combe, Barbour, & Combe are generally 10 inch diameter, and at an angle of 50°.

Messrs S. Lawson & Sons' Roving.

We herewith give seven drawings of the roving frames made by Messrs Samuel Lawson & Sons, Ltd., Leeds. The first drawing shows the Gearing End Elevation, the second the Sectional Elevation, the third Back Elevation—Gearing and Friction Plate, and the fourth Front Elevation—Driving End. In the fourth it may be pointed out that the pressing rollers are shown as having leathern ends, which this firm have recently introduced, and which they hold as particularly suitable for roving frames for jute preparing in India. In addition to the roving frame made with a friction plate, this firm also make roving frames with the cone motion, as shown in drawings Nos. 5, 6, and 7.

Unlike the roving frames of the other two makers, the gearing of those made by the above firm is arranged all on one side of the frame. From the pulley pinion we have the drawing roller, spindles, and top cone

driven. In this roving we have two cones, the top one having an unvariable speed, the lower one being variable, the various speeds of which we require in our present calculation; and, besides these, the back shaft is also driven from the pulley shaft. As already stated, there is no difference in the calculation to find the speed of the driver of the differential wheel in the roving frames of the three different makers, but the difference exists in the means applied to vary the differential wheel speed. Proceeding as in the last case to find the speed which we require the lower cone or driver of the differential wheel when the bobbin is empty, we have—

$$\frac{140 \times 30}{15} = 280 \text{ speed of pulley shaft.}$$

$$\frac{280 \times 48 \times 24}{32 \times 18} = 560 \text{ speed of spindles.}$$

$$\frac{280 \times 48 \times 48 \times 7{\cdot}06}{64 \times 78} = 912{\cdot}37 \text{ delivery of drawing roller.}$$

$$\frac{280 \times 48 \times 48}{64 \times 48} = 210 \text{ speed of top cone.}$$

Diameters of bobbins at start, $1\frac{1}{4}$ in.
Circumference of do. 3·927 in.

$$\frac{912{\cdot}37}{3{\cdot}927} = 232{\cdot}33 \text{ revolutions of flyers to put on delivery.}$$

Speed of spdls. Revols. of flyers.
560 — 232·33 = 327·67 speed of bobbins.

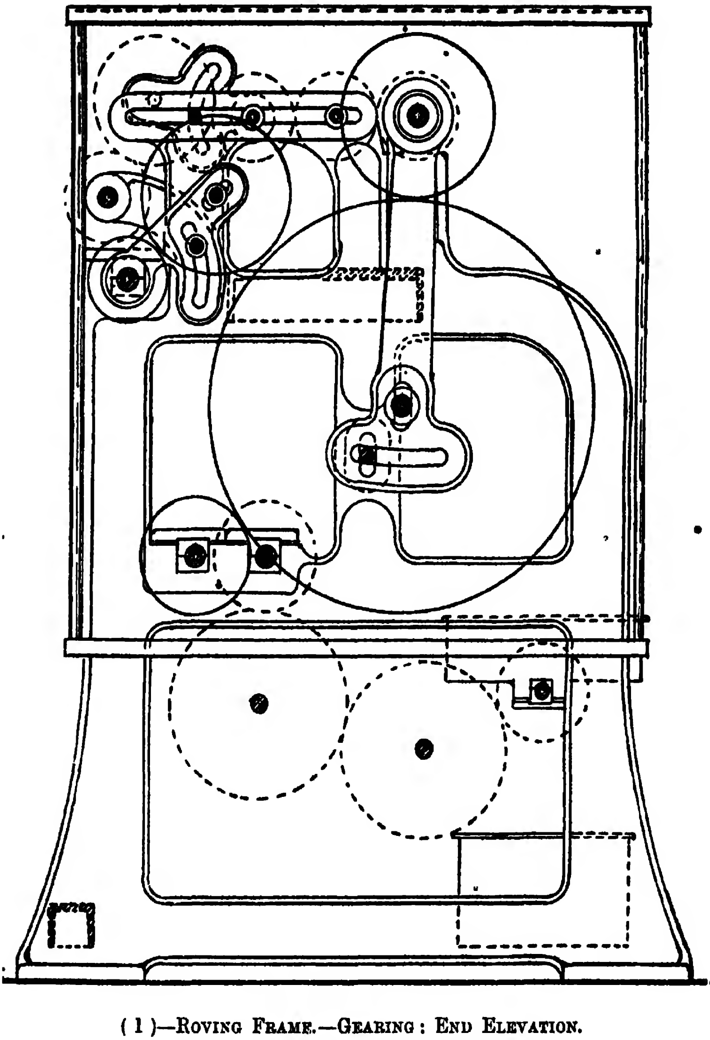
$$\frac{327{\cdot}67 \times 18 \times 32}{24 \times 48} = 163{\cdot}83 \text{ speed of socket.}$$

Speed of pulley shaft. Speed of socket.
280 — 163·83 = 116·17 revols. socket requires to be less than pulley shaft.

$$\frac{116{\cdot}17}{2} = 58{\cdot}08 \text{ speed of differential wheel.}$$

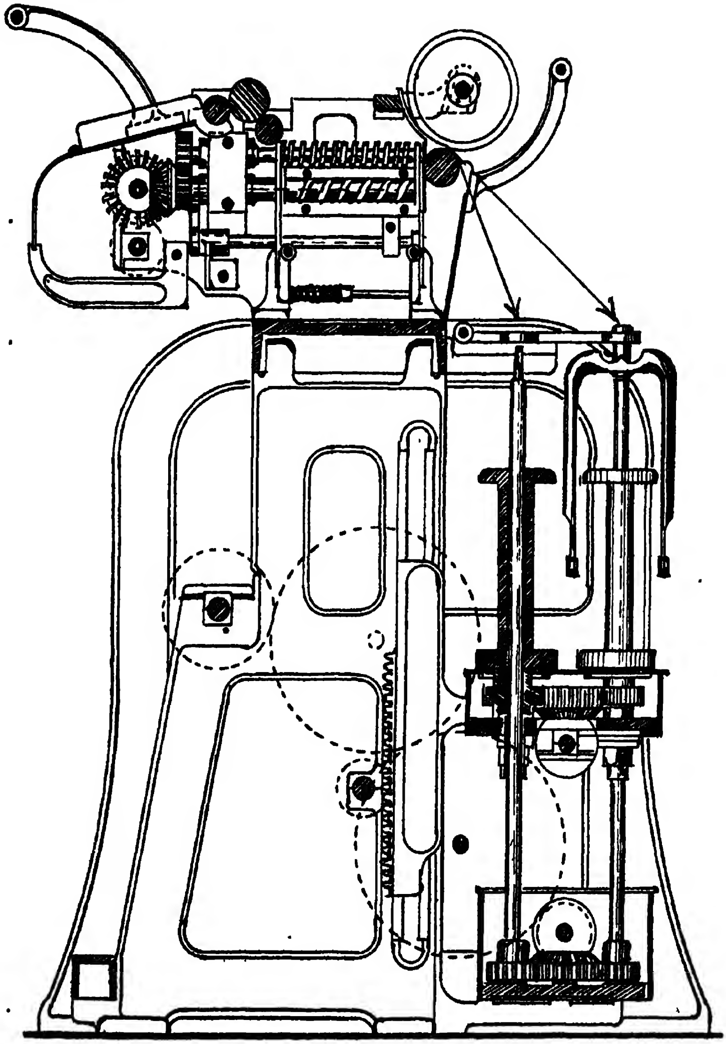
$$\frac{58{\cdot}08 \times 210 \times 25}{26 \times 26} = 451{\cdot}06 \text{ speed of lower cone at start with bobbin } 1\tfrac{1}{4} \text{ in. diameter.}$$

Having found that we require the speed of the lower cone, which drives the differential wheel, to be 451·06 revolutions at the start, the bobbin being $1\frac{1}{4}$ in. diameter, we must now determine the size and construction of our



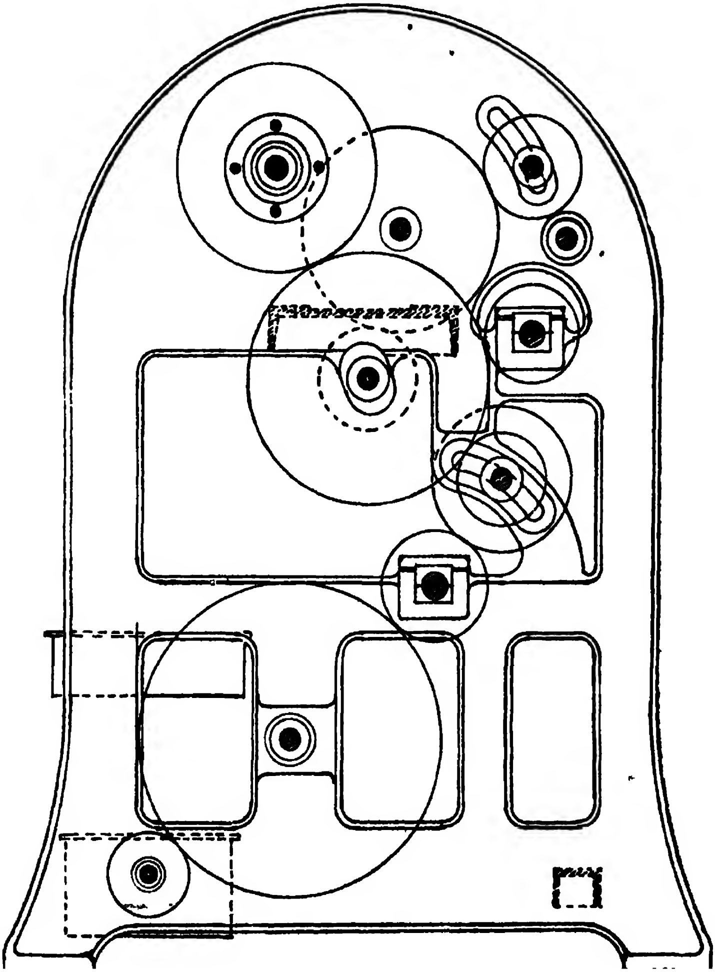
(1)—ROVING FRAME.—GEARING : END ELEVATION.

(Messrs S. LAWSON & SONS.)



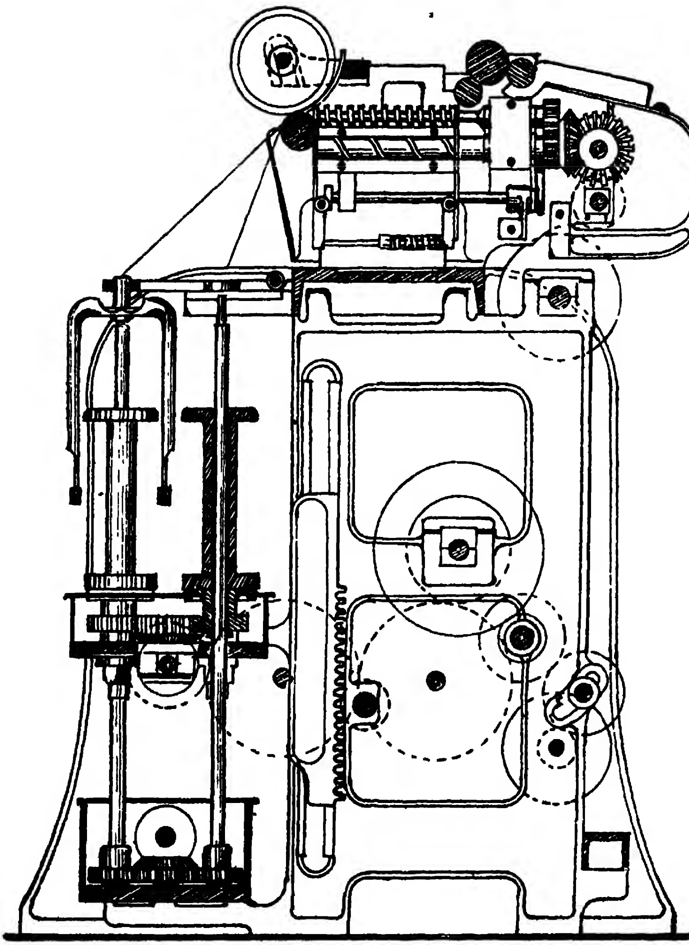
(2)—ROVING FRAME.—SECTIONAL ELEVATION.

(Messrs S. LAWSON & SONS.)



(5)—Roving Frame (Cone Motion).—Gearing: End Elevation.

(Messrs S. Lawson & Sons.)



(6)—Roving Frame (Cone Motion).—Sectional Elevation.

(Messrs S. Lawson & Sons.)

cones, and cannot find the diameters at each increase in diameter of the bobbins by proportion, as in the expansion pulley calculation, or by inverse proportion, as in disc. I will give a very simple rule or formula for finding the shape of the cones, but, in order to make it as clear as possible, will give first an example of how to construct the cones from the various speeds at which the lower cone requires to be at each increase of diameter of the bobbin. By inverse proportion we can find the speed the lower cone requires to be at each increase of the bobbin diameter.

For example, we have found that at the start, with bobbin $1\frac{1}{4}$ in. diameter, we require 451·06 revolutions. Supposing our bobbin increases one-eighth of an inch in diameter every row that is put on, we can find the speed the lower cone requires to be when the bobbin increases to $1\frac{3}{8}$ in. diameter, $1\frac{3}{8} : 1\frac{1}{4} :: 451{\cdot}06 = 410{\cdot}05$ speed of cone when bobbin is $1\frac{3}{8}$ in. diameter.

In the same way we can find the various speeds at each increase up to any size, and supposing we wish to have our cone to suit a bobbin $5\frac{1}{2}$ in. diameter, we have as before, $5\frac{1}{2} : 1\frac{1}{4} :: 451{\cdot}06 = 102{\cdot}51$ speed of cone when bobbin is $5\frac{1}{2}$ in. diameter.

Having the speed of our top cone 210, and its diameter at the extreme end 6 in., and the diameter of lower cone at the same point $2\frac{1}{4}$ in., we have $\frac{210 \times 6}{2\frac{1}{4}} = 560$ the speed of the low cone. We can next determine what diameter of bobbin this speed would suit. $560 : 451{\cdot}06 :: 1\frac{1}{4} = 1$ in. diameter of bobbin.

Determining the length we wish the cone to be, then from the following table we can make our cone the required shape. As the sum of the diameters of the two cones remains the same throughout their entire length it will be sufficient to ascertain one. Suppose the length of our cone to be $31\frac{1}{2}$ in.; speeds required to suit bobbin from 1 in. to $5\frac{1}{2}$ in. diameter, increasing one-eighth of an inch each row of rove, as in the previous table, it will be seen that we require to know the diameter of one of the cones at 37 points. Let us

first take a straight line the length of our cones, $31\frac{1}{2}$ in., and divide it into 36 equal parts. Commencing at the first point, that is, the largest diameter of the top cone, which we have fixed at 6 in., then at the second point of the cone we require a diameter less than 6 in., which multiplied by 210, the speed of top cone, and divided by the diameter of the low cone, $2\frac{1}{4}$ in., plus the amount which our top cone will be less than 6 in., shall equal 501·18 the speed of the lower cone when the bobbin is $1\frac{1}{8}$ in. diameter.

TABLE SHOWING SPEED OF LOWER CONE AT EACH INCREASE IN DIAMETER OF BOBBINS.

Diameter of Bobbin.	Speed of Cone.	Diameter of Bobbin.	Speed of Cone.	Diameter of Bobbin.	Speed of Cone.
Inches.		Inches		Inches	
1	560	$2\frac{1}{2}$	225.52	4	140 95
$1\frac{1}{8}$	501·18	$2\frac{5}{8}$	214·78	$4\frac{1}{8}$	136·68
$1\frac{1}{4}$	451·06	$2\frac{3}{4}$	205·02	$4\frac{1}{4}$	132·66
$1\frac{3}{8}$	410·05	$2\frac{7}{8}$	196·11	$4\frac{3}{8}$	128·87
$1\frac{1}{2}$	375·88	3	187·94	$4\frac{1}{2}$	125·29
$1\frac{5}{8}$	347	$3\frac{1}{8}$	180·42	$4\frac{5}{8}$	121·9
$1\frac{3}{4}$	322·18	$3\frac{1}{4}$	173·48	$4\frac{3}{4}$	118·7
$1\frac{7}{8}$	300·7	$3\frac{3}{8}$	167·05	$4\frac{7}{8}$	115·65
2	281 91	$3\frac{1}{2}$	161 09	5	112·76
$2\frac{1}{8}$	265·30	$3\frac{5}{8}$	155·53	$5\frac{1}{8}$	110
$2\frac{1}{4}$	250·58	$3\frac{3}{4}$	150·35	$5\frac{1}{4}$	107·4
$2\frac{3}{8}$	237·4	$3\frac{7}{8}$	145·50	$5\frac{3}{8}$	104·9
				$5\frac{1}{2}$	102·51

Let us suppose x = diameter of the top cone at first division, low cone will then be equal to the sum of the diameters, $6+2\frac{1}{4}=8\frac{1}{4}-x$.

Thus we have $\frac{x \times 210}{8\frac{1}{4}-x}=501·18$

Simplifying, we have

$$210\,x=4134·735-501·18\,x.$$

$$711·18\,x=4134·735$$

$x=\frac{4134·735}{711·18}=5·813$ diameter of top cone at second point for bobbin, $1\frac{1}{8}$ in.

Proceeding in the same way, we can find the dia-

meter of the cone at each division, and at the opposite ends we have

$$\frac{x \times 210}{8\frac{1}{4} - x} = 102{\cdot}51$$

Simplifying, $210x = 845{\cdot}727 - 102{\cdot}51\ x$.

$$312{\cdot}51\ x = 845{\cdot}727$$

$x = \dfrac{845{\cdot}727}{312{\cdot}51} = 2{\cdot}706$ diameter at small end or thirty-seventh point of top cone, bobbin being $5\frac{1}{2}$ in.

The foregoing equation may be put in the following manner:—

Add the revolutions of top cone, 210, to the revolutions required at each diameter of the bobbin, and divide it into the revolutions required, multiplied by the sum of the diameters of the cones, $8\frac{1}{4}$ in., for the diameter of the top cone at each point. Having ascertained the diameter of the top cone at each division, we can find the diameter of the low cone. Thus, at the first division top cone diameter $= 5{\cdot}813$ or $5\frac{13}{16}$, low cone diameter then $= 8{\cdot}25 - 5{\cdot}813 = 2{\cdot}437$ or $2\frac{7}{16}$. At the last point, top cone diameter $= 2{\cdot}706$, and low cone $= 8{\cdot}25 - 2{\cdot}706 = 5{\cdot}544$ in. diameter.

Another method of determining the Cones.—Having fixed the end diameters of the cone required, the axis lying between these diameters may be divided into as many parts as desirable. The diameter of the cone at any of these parts can be found by the following rule:—Multiply the number of divisions by greater diameter, and divide the result by number of divisions plus the number of the division at which we require the diameter.

Example.—Let the end diameters of the cone be 6 in. and 3 in. respectively. This necessitates a length of cone equal to $31\frac{1}{2}$ in. Divide this length into, say, thirty equal parts, then, by the rule given above, we find the diameter at any of the divisions; thus, at division 20 we have $\dfrac{6 \times 30}{30 + 20} = 3\frac{3}{5}$ inches.

It must not be supposed that the length, 31½ inches, is got arbitrarily; it depends entirely on the required diameters, which are taken by actual measurement on a cone from a hyperbole or rather adjacent hyperboles formed to suit the greater diameter.

The rule itself is based on certain properties peculiar to the hyperbole (conic sections), but which we cannot here discuss.

Note.—We have here been speaking of the formation of the upper cone; the lower is made to suit it, as explained in former method.

These cones, as now determined, will do for any size of rove, whether our bobbin diameter increases by one-sixteenth, one-eighth, or one-fourth of an inch, &c.

A belt running perpendicularly conveys the power from the top to the low cone, and at the start this belt must be placed on the proper diameter of the cone determined by the diameter of the bobbin barrel.

A rack moves the belt guide, and this rack is acted upon by a ratchet wheel, which is allowed to move round half a tooth each time the builder rises or falls. Now, if we have a rove increasing one-eighth of an inch, the ratchet wheel should be of such a pitch as to allow the belt to be moved one division in each rise and fall of the builder.

If, however, you have a rove increasing the diameter of the bobbin one-sixteenth of an inch in every row of rove put on, you will require a ratchet pinion with twice as many teeth, or the teeth half the pitch; and if you have one increasing the bobbin diameter one-fourth of an inch, you will require one with half the teeth of that for the one-eighth of an inch increase, or the pitch of teeth twice as much, so as to put your belt at each rise and fall of the builder one-half, or twice as far as with one-eighth of an inch increase, and so with any larger, smaller, or intermediate rove.

Messrs Fairbairn, Naylor, Macpherson & Co.'s Roving.

Disc and Scroll.—The mode of action differs considerably from the other two in this means of regulating the speed of the differential wheel. In those we have the diameters of pulleys and driven cone increasing, while in this the diameter of the disc which drives the boll diminishes. Again, in the expansion pulleys the increase is regular, while in the cones and disc the decrease in diameter is irregular. Proceeding in the same way as in the two former calculations, we shall obtain the diameter on the disc at which the boll or friction pulley must be placed at the start.

$\frac{125 \times 26}{16{\cdot}25} = 200$ speed of pulley shaft.

$\frac{200 \times 44 \times 30}{22 \times 20} = 600$ speed of spindles.

$\frac{200 \times 28 \times 78{\cdot}5}{54} = 814$ inches delivered by drawing roller.

$\frac{200 \times 28}{54} = 104$ speed of drawing roller.

Diameter of bobbin barrel $1\frac{1}{4}$ = circumference 3·92 in.

$\frac{814}{3{\cdot}92} = 207{\cdot}65$ revolutions flyers require to put on quantity delivered.

$600 - 207{\cdot}65 = 392{\cdot}35$ speed of bobbins.

$\frac{392{\cdot}35 \times 12 \times 30 \times 36 \times 32}{18 \times 36 \times 48 \times 40} = 130{\cdot}78$ speed of socket.

$200 - 130{\cdot}78 = \frac{69{\cdot}22}{2} = 34{\cdot}61$ speed of differential wheel.

$\frac{34{\cdot}61 \times 84 \times 72}{12 \times 27} = 646{\cdot}05$ speed of friction pulley or boll at start.

The motion of the disc or friction plate which drives the friction pulley or boll comes from the pulley shaft, so that we multiply the speed of the pulley shaft by the twist wheel, divided by the wheel on the end of the shaft which drives the friction plate $\frac{200 \times 28}{27} = 207$. Then, having the speed required from the friction pulley 646·05, the

speed of the friction plate or disc 207, and the diameter of the friction pulley 5 in., we can find the diameter on the disc at which the friction pulley must be placed; or, in other words, the diameter of the driver $\frac{646{\cdot}05 \times 5}{207} = 15{\cdot}6$ diameter at which the boll or friction pulley must be placed on the disc, and, of course, half this distance from the centre. Having obtained diameter on disc 15·6, with bobbin barrel $1\frac{1}{4}$ in. diameter, let us suppose the bobbin diameter increases one eighth of an inch each row that is put on, the bobbin 4 in. diameter when full, then we require $4 - 1\frac{1}{4} = 2\frac{3}{4} = 22$ traverses. The first row being put on, the diameter is $1\frac{3}{8}$ in.; as in the other cases substituting this for $1\frac{1}{4}$ in., in the calculation we have 14·18; for $1\frac{1}{2}$, 13; and so on. In the expansion pulleys we find the increase by simple proportion. Let us take the two increases already taken from $1\frac{1}{4}$ in. to $1\frac{3}{8}$ in., and $1\frac{3}{8}$ in. to $1\frac{1}{2}$ in. Thus, if $1\frac{1}{4}$ in. diameter of barrel requires, as we find, 15·6 diameter on the disc, what will $1\frac{3}{8}$ in. require? According to simple proportion, $1\frac{3}{8}$ in. would require more, and so we would state similar to the expansion pulley calculation, but, unlike the pulleys, the diameter on the disc diminishes as the bobbin fills; so we must put the lesser in the second place. As $1\frac{3}{8} : 1\frac{1}{4} :: 15{\cdot}6 = 14{\cdot}18$. Again, with the next increase we have $1\frac{1}{2} : 1\frac{1}{4} :: 15{\cdot}6 = 13$. This is inverse proportion, and by this means we find the following table:—

Diameter of Bobbin.	Diameter on Disc.	½ Diameter on Disc.	Diameter of Bobbin.	Diameter on Disc.	½ Diameter on Disc.	Diameter of Bobbin.	Diameter on Disc.	½ Diameter on Disc.
$1\frac{1}{4}$	15·6	7·8	$2\frac{3}{8}$	8·21	4·1	$3\frac{1}{2}$	5·571	2·78
$1\frac{3}{8}$	14·18	7·09	$2\frac{1}{2}$	7·8	3·9	$3\frac{5}{8}$	5·379	2·689
$1\frac{1}{2}$	13	6·5	$2\frac{5}{8}$	7·428	3·714	$3\frac{3}{4}$	5·2	2·6
$1\frac{5}{8}$	12	6	$2\frac{3}{4}$	7·09	3·54	$3\frac{7}{8}$	5·032	2·5
$1\frac{3}{4}$	11·143	5·57	$2\frac{7}{8}$	6·782	3·396			
$1\frac{7}{8}$	10·4	5·2	3	6·5	3·25			
2	9 75	4·87	$3\frac{1}{8}$	6·24	3·12			
$2\frac{1}{8}$	9·176	4 588	$3\frac{1}{4}$	6	3			
$2\frac{1}{4}$	8·666	4·33	$3\frac{3}{8}$	5·777	2·888			

If we compare the decrease on the disc at each step we will see that it is not regular; from $1\frac{1}{4}$ to $1\frac{3}{8}$ on the bobbin the boll moves from 15·6 to 14·18, a decrease of 1·42 on the disc; then from $3\frac{3}{4}$ to $3\frac{7}{8}$ on the bobbin it moves from 5·2 to 5·032, decrease of ·168; whereas for the same increase of the bobbin at the start we had decrease of 1·42. From this it will be seen that the boll moves less as it comes nearer the centre and as the bobbin fills. In order to give this irregular decrease of the diameter of the boll on the disc, the scroll or snail is introduced. We will now consider the manner in which the peculiar form of the scroll is obtained. The scroll is on the same shaft as the ratchet wheel. From the boll extends a shaft which moves it out and in on the disc, and when the boll is at 15·6 in. diameter on the disc at starting, the end of this shaft bears upon the end of the scroll farthest from the centre, and as the ratchet turns round so does the scroll, and by a lever and weight the boll shaft is kept bearing on the scroll, so that as the distance from the centre of the scroll to the point where the boll shaft bears diminishes so also the diameter on the disc diminishes. Knowing that 15·6 in. is the diameter on the disc at the start, we have the half of this, 7·8, the radius on the disc, or the distance of the boll from the centre of the disc. Supposing the distance from the centre of the scroll to the farthest point is the same, namely, 7·8, then, as the disc diminishes, so exactly will the scroll. Referring to the table, we have the diameter on the disc at the finish 5·032, the radius 2·5 in., and so the scroll must diminish to 2·5 from the centre to the part where the boll shaft rests. Having the two extreme points, as well as the intermediate diameters of the disc at each shift, we will proceed to consider how the scroll is formed.

From a centre, which we will suppose is the centre of the shaft on which the scroll is placed, describe a circle with a radius 7·8 in., which we shall call B, and also describe a circle A from the same centre with a radius 2·5 in. Now, the boll shaft moves from the circle B to A in filling the bobbin. If we re-

quired one complete turn of the scroll to accomplish our work, then, drawing a line from the centre to the outer circle B, the points at which this line would cut A and B would give us the points where the boll shaft would be at beginning and end. However, three-quarters of the circle is generally found sufficient.

From any point on the circumference of B divide the three-fourths of the circle into twenty-two equal parts, and draw a line from the centre to each point. On these lines we have now to mark off the distances given in the table. The first point we have already got, being the distance to circumference of B 7·8. On the second radius mark off the second distance, as in the table, 7·09; on the third 6·5; and so on, finishing on the twenty-second with 2·5. Commencing on the first line on the circumference of B, drawing a line joining these points and finishing at the circumference of A, we have the form of scroll required, and, as in the other two, if we place on a ratchet wheel which turns the scroll at each rise and fall of the builder one of these equal distances, it causes the boll to move on the disc the required distance each row of rove.

For the same reason as in the cone and expansion pulleys, this scroll will do for any size of rove from 1¼ in. to 4 in. diameter. In this case we stopped when we had just enough, but they are generally made with a few more points than are actually needed.

Speed of the Builder.—On the speed of the builder depends the laying on of the rove on the bobbin, and the rows should not overlap or be too far apart. Just as the speed of the bobbin alters, for similar reasons so must the speed of the builder, and, like the bobbin, its motion is regulated by the disc, cone, or expansion pulleys, as the case may be, and varies its speed accordingly. If, however, the builder is either overlapping or laying the rows on too far apart, this can be easily altered by making its pinion larger or smaller.

Effect of changing the Twist Wheel.—The twist wheel occupies such a position in the roving that altering it alters the speed of every part of the frame except the spindles; but although this is the case, they preserve always the same relations to one another. If you put on a larger twist wheel you drive the roller quicker, and so you require the bobbins slower; but the larger twist wheel also drives the disc, cone, or pulleys proportionally quicker, and these the differential wheels quicker, thus giving the slower speed required to bobbins.

Another mode of Uptake.—By driving the bobbin faster than the spindle, the rove may be pulled on instead of being laid on, as explained, and it would just vary its speed when a leader, diminishing instead of increasing as it increases in diameter, and going at the surface speed of the drawing roller faster than the spindle motion.

Let us suppose a few difficulties with the roving, and suggest solutions.

In the disc, the boll requires examination from time to time, to see that it does not diminish in diameter, without making compensation by putting it nearer the centre on the disc by means of the rod for this purpose.

Again, if your bobbin is dragging, or keeping the sliver too tight and injuring it, you require to drive the bobbin faster, hence the boll, the cone, and expansion pulleys must go slower. In the disc you bring the boll nearer the centre, but if you now have not room on the disc to fill the bobbin, you must alter the pinion which drives the disc plate, making it larger, and driving the disc slower, and then place your boll properly. In a similar way you would treat the cone. If you have not large or small enough diameters on expansion pulleys, you require to alter the change pinion leading to or immediately before the differential wheel. I might give many other ways of altering, but they are seldom needed, and in any case where alteration may be needed, the foregoing will act as a guide where to change.

Conclusion of Differential Motion.—We may safely say that the roving and its complicated motions is one of the most difficult problems to master in our flax spinning mills; but although intricate, it has, when properly arranged, a delicacy of treating rove for the finest wet spun yarn as well as for the heaviest jute yarn.

Preparing flax

For Dry Spinning or Heavy Numbers.

In dealing with the preparing for dry spinning I have an easy task. As the preparing or making the rove for dry spinning is exactly similar in every respect to that for wet spun yarns, I shall refer my readers to the process as dealt with there. However, as stated in the Introductory notice, dry spinning is employed for the heavier yarns, so the preparing is coarser than in wet spinning. The range of dry flax yarn is from 1½ lbs. to 20 lbs. per spindle, yarns for ordinary linens running up to 4 or 5 lbs. per spindle; canvas yarns from 4½ and 5 lbs. to 20 lbs. per spindle. Yarn 3 lbs. per spindle may be considered as the standard size. Almost as great care is required in preparing flax for these as for finer yarns, for, although we have not so costly, we have weaker material, which will not stand rough usage. Russian flax is principally used in the dry spinning trade—Riga K marks, 12 and 9 head, low Pernau marks, such as HD and D, Hoff, Archangel, Rjeff, &c. &c. From the nature of these flaxes, it is essential that drafts in the preparing should be shorter than in strong flax for wet spinning; these drafts should never exceed 12, and if below it, so much the better. The gills should be more open than for the more solid and well cut flax, giving perfect freedom of action without allowing it to run into layers; gills too fine would also cause imperfect drawing and breaking of the fibre, and a longer pin is required, owing to its light, bulky character. An incident that came under our observation a good number of years ago illustrates this view. Two systems, exactly the same in every par-

ticular of construction, were working alongside each other; both were working the same flax exactly, for the same size—3 lbs. The rove weighed the same, and they were spun over frames exactly similar, although in different rooms. The yarn of what we will term No. 1 system was very inferior to the yarn from No. 2 system, No. 1 being hairy, having more "swells" and "smalls," and wanting entirely the skin and strength of No. 2 system. Any inferiority about these 3 lbs. (the work of the two systems being mixed) was set down as being due to No. 1 system, and everything that was thought of at the time was tried, and failed to have the desired effect, until we examined the drafts of the preparing, and found No. 1 about 11, and No. 2 about 10 draft all over. We changed No. 1 to 10, and found any defect remedied. The explanation of this is that the gills being too small, the material weak and poor, and with the longer draft on No. 1 more burdened, the flax ran over the top of the gills a little, and so we had inferior yarn.]

Clock Weighing System.

As we mentioned in connection with the preparing for wet spun yarns, keeping the rove at a uniform rate is accomplished by weighing cans in setts. As clocks are used more or less in the preparing for dry spinning, and as we have had a practical acquaintance with both systems as applied to wet and dry spun yarns, flax, tow, and jute, we will here give an explanation of the above system.

Working of the Clock.—The principle of the clock or dial is as follows:—A certain quantity is spread in one round, or some part of a round, of the dial of the clock. The clock is driven from the delivering boss similar to the bell in sett weight. A worm on the end of the delivering boss shaft drives a pinion on a shaft which has on the other end a bevel pinion driving

a similar bevel pinion on an upright shaft, having a worm on the opposite end that drives a pinion carrying round the hand on the dial of the clock. This is the usual system, although it is driven in many cases more directly.

Length of the Clock.—The length is taken, as in the case of the bell, by multiplying the circumference of the delivering boss by the pinion on the end of the small shaft leading to the clock, and on the opposite end of this shaft a bevel pinion drives a similar bevel pinion which we multiply by, and again multiply by the pinion on the dial, and divide by the first bevel pinion and by 36 to reduce to yards.

Example.—Diameter of delivering boss 4 in. = circumference 12·56, first or change pinion 48, first bevel 25, second bevel 25, dial pinion 60. Thus:

$$\frac{12\cdot56 \times 48 \times 25 \times 60}{36 \times 25} = 1004 \text{ yards.}$$

In putting on a new size, proceed as in sett weight, and find the weight required for 100 yards from spreadboard. Say that is 5 lbs., then for 1000 yards (if that is the length of our clock, for we may suppose that not more than 1000 is delivered by drawing roller, as the delivering boss requires at least four more to keep the sliver sufficiently tight), we would require 5 lbs. × 10 = 50 lbs. As in sett, allow for waste and bulking.

After once getting data to work from, the different weights of rove are obtained by proportion, altering the change pinion on the end next the delivering boss, instead of the weight of flax every time, which would be very awkward, as the flax is generally put up in bundles of the same weight. Thus, supposing your flax is put up in bundles of 25 lbs. each, and you spread two at a time, which equals 50 lbs., then you make your rove heavier or lighter by lengthening or shortening the length of the clock. The greater length the 50 lbs. goes into, the lighter the sliver, and *vice versa.*

Example.—[If a 48 pinion gives us 48 drs. per 100 yards of rove, and we require 36 drs. per 100 yards, what pinion will be required, always the same weight being spread? As

drs.		drs.		pinion	ans.
36	:	48	::	48;	64 pinion required.]

To find Weight and Length of Clock for a given Rove.—Again, supposing we have no data to start from in a system, with particulars as follows:—

First drawing, draft	= 10,	Ends into 1	= 12
Second " "	= 12,	" 1	= 12
Third " "	= 12,	" 1	= 4
Roving	= 12,		

Rove required, 51 drs. per 100 yards, length of clock 1000 yards, we have $\frac{51 \times 12 \times 12 \times 12 \times 10}{4 \times 12 \times 12 \times 16 \times 16} = 6$ lbs. per 100 yards from spreadboard.

Now, if 6 lbs. is the weight of 100 yards, then 1000 yards, which is the present length of the clock, will require ten times as much, 6 lbs. × 10 = 60 lbs., or 30 lbs. to be spread by each spreader in one round of the clock. Now, if our flax is put up in any other weight, say 25 lbs., we can find the length of bell in this way. We require, as shown above, 6 lbs. per 100 yards, then what length will give us 50 lbs., or two bunches to spread? 6 : 50 :: 100 yards: ans. 833⅓ yards length of clock. This is without taking into account waste, bulking, &c.

In order to know the explanation of this rule, see the way to find sett weight, or weight of 100 yards of sliver from spreadboard, from weight of rove per 100 yards in "preparing for wet spinning." There is this difference, however: in it, as the sett is made up at the back of the first drawing, its doublings are not taken into consideration, as the weight found is the weight of the whole sett; but as the weight is made up in the clock system for a single sliver delivered from the spreadboard, you divide by the number of doublings at the back of the first drawing, and thus you have the weight of one

sliver. We shall sum up our opinion of both systems (clock and sett) in very few words. Do not use the clock system if you can use the sett. The clock system with coarse yarn equally with fine produces the same result. With the sett you can run a size of yard for an indefinite time without altering your draft in the spinning room. With the clock system your yarn keeps rising and falling, heavy to-day and light to-morrow, heavy this doffing of rove and light the next, and more common still, heavy and light mixed through them all. On examining the yarn you can never fail to find heavy and light cuts, and it is even easier seen on the bobbins. A doffing of bobbins never comes off a spinning frame prepared by the clock system out of which one could not select from their appearance some light and some heavy, and commonly there will be in heavy yarns, where slight differences are easily seen, a difficulty in picking out many bobbins which are exactly the same. In the sett system, with just the same amount of care, you have results the very reverse, no difference whatever in the size of the yarn being visible. In the sett, you have eight, ten, or any set number of cans, with exactly the same number of yards in each, and these combined have always the same weight. Now, if the spreaders make heavy or light cans their attention is called to it and they are balanced by others, whereas in the clock there is no check so long as the worker spreads the allotted quantity in a round of the clock. There will be heavy and light slivers spread, and it is the getting together on the sett frame of too many light or heavy slivers that prevents equality. That the sett is by far the superior system we have no hesitation in saying. That the clocks are easier and cheaper is urged on their behalf, but the inferiority of the work produced discounts this consideration. At any rate, yarn not heavier than 6 lbs. or 8 lea, in my opinion, should have the sett. On account of the inequalities of the clock system, you have roves below the proper weight, which constantly annoy the spinner.

A few light roves are sufficient to keep a spinning frame in bad order, so that you are not able to take off the same production. Again, from sudden fluctuations the roves in general take, you require to put on draft when perhaps you have some of the previous lighter roves still on the frame. So that, although the clock system in the preparing room may be easier and cheaper, its merits in this department are more than counterbalanced by its defects in the spinning room. Following it further, you have unequal wefts, which make alternate light and heavy cloth; besides, you have breaking in the weaving of the light warp yarns.

A serious defect, in working six or more different sorts of flax, is that you cannot efficiently have more than two different qualities running at one time, as the flax is suspended from a balance.

Working of Balance and Clock.—The dial of the clock driven by the machine is divided into a certain number of equal parts, say twelve, and a ring is put on the balance, also divided into twelve equal parts, between the place where the hand of the balance points when the full weight is in and when empty, so that, as the hand on the machine-clock moves from twelve to eleven, there should be enough spread to move the hand of the balance on which the flax is suspended from twelve to eleven on the index ring, equal to one-twelfth of 25 lbs. spread. It is urged from this that the spreader has a check every two lbs. spread, but it is generally the case that, after getting an idea of the weight to be spread, the spreader never compares the index ring of the balance with the machine-clock until the allotted quantity is almost finished, thus making the rove by guess work. On the other hand, the spreader for setts spreads uniformly from beginning to end of the bell, and then finds whether the spreading is heavy or light, and thus regulates the spreading until right, and continues always the same, without the temptation, as with the clock motion, to spread heavier or lighter, so as to finish with the machine-clock. In the setts you can

spread six different sorts at the same time, if a six-line spreader, and so have your sliver uniformly mixed at the first machine.

In the wet spinning trade very few use the clocks, the sett being almost universal. In some places where clocks are used, for the proper mixing of the flax only one sort is spread at a time, and then the cans put up with the right mixture at the first drawing frame, and if this trouble has to be resorted to, why not weigh them with very little extra trouble? if this is done, the clocks will be found of little use. In the dry spinning trade the clock system is frequently used, but setts are used for the better class of yarns. Sometimes setts are made up from the first or second drawing, two or four cans at a time, but the objections to this are evident in comparison to eight, ten, or twelve cans, and the sett made up from the spread-board is considered preferable to that of any other method.

In twisting the rove, more attention is required than in preparing for wet spinning, but as the preparing over-seer should be guided in this matter by the opinion of the spinning overseer, we will leave it to be treated in spinning. Greater doubling can be accomplished with short drafts in preparing these heavy numbers than in lighter, without resorting to very light spreading, one to three thousand doublings being generally used. To ascertain the amount of doubling simply multiply together the number of ends into one at first, second, and third drawings, thus, $12 \times 12 \times 8 = 1152$ doublings on the system.

The following tables are similar to those previously given, pages 58, 59, the same explanation applying.

TABLE SHOWING FLAX REQUIRED FOR 100 SPINDLES OF YARN.

Weight in lbs. per Spindle.	Leas.	Weight of 100 Spindles	100 Spdls Flax wasting 10 per cent.	100 Spdls Flax wasting 12 per cent	100 Spdls. Flax wasting 14 per cent.	100 Spdls. Flax wasting 15 per cent.	100 Spdls. Flax wasting 18 per cent.	100 Spdls. Flax wasting 20 per cent.	100 Spdls. Flax wasting 22 per cent.
15	3·2	1500	1666·66	1704·54	1744·18	1764·7	1829·26	1875	1923·07
14	3·43	1400	1555·55	1590·9	1627·9	1647 06	1707 31	1750	1794·84
13	3·69	1300	1444·44	1477·27	1511·63	1529 41	1585·36	1625	1666·66
12	4	1200	1333·33	1363·63	1395·35	1411·76	1463·41	1500	1538·46
11	4·36	1100	1222·22	1250	1279·07	1294·11	1341·46	1375	1410·25
10	4·8	1000	1111·11	1136·35	1162 79	1176 47	1219·51	1250	1282·05
9	5·33	900	1000	1022 71	1046·51	1058·82	1097·56	1125	1153·84
8·5	5·65	850	944·44	965·9	988 37	1000	1036 58	1062·5	1089·74
8	6	800	888·88	909 09	930 23	941·18	975·60	1000	1025·64
7·5	6·4	750	833·33	852·27	872 09	882·35	914·63	937·5	961·53
7	6·86	700	777·77	795 45	813·95	823·52	853·66	875	897·43
6·5	7·38	650	722·22	738·63	755 81	764·70	792·68	812·5	833·33
6	8	600	666·66	681·81	697·67	705·88	731·70	750	769·23
5·75	8 34	575	638·88	653·40	668·60	676·47	701·22	718·75	737·18
5·50	8·73	550	611·11	625	639·53	647·05	670 73	687·5	705·12
5·25	9·14	525	583 33	596·59	610·46	617·64	640·24	656·25	673·07
5	9.6	500	555·55	568·17	581·39	588·23	609·75	625	641·02
4·75	10·10	475	527·77	539·77	552 32	558·82	579·27	593·75	608·97
4·50	10·66	450	500	511·35	523 25	529·40	548·78	562·5	576·92
4·25	11·29	425	472 22	482·94	494·18	500	518·29	531·25	544·87
4	12	400	444 44	454 54	465·11	470·58	487·80	500	512·82
3·75	12·80	375	416·66	426 13	436 04	441·17	457·31	468·75	480·77
3·50	13·71	350	388·88	397·71	406 97	411·76	426·83	437·5	448·71
3 25	14·76	325	361·11	369·31	377 90	382·35	396·34	406·25	416·66
3	16	300	333 33	340·90	348·83	352·94	365·85	375	384·61
2·75	17·45	275	305·55	312 5	319·76	323·53	335·36	343·75	352·56
2·50	19·2	250	277 77	284·08	290·69	294·11	304·87	312·5	320·51
2 4	20	240	266·66	272·71	279·07	282·35	292·68	300	307·69
2·25	21·33	225	250	255·60	261·63	264·70	274·39	281·25	288·46
2·18	22	218	242·22	247·71	253·48	256·47	265·85	272·5	279 48
2	24	200	222·22	227·27	232·55	235·29	243·9	250	256·41
1 92	25	192	213 33	218 17	223·25	225·88	234·14	240	246·15
1·71	28	171	190	194 32	198·83	201·17	208·53	213·75	219·23
1·6	30	160	177·77	181·82	186·04	188·23	195·12	200	205·12
1·5	32	150	166·66	170·45	174·41	176·47	182·92	187·5	192·30

Table Showing Tow Required for 100 Spindles of Yarn.

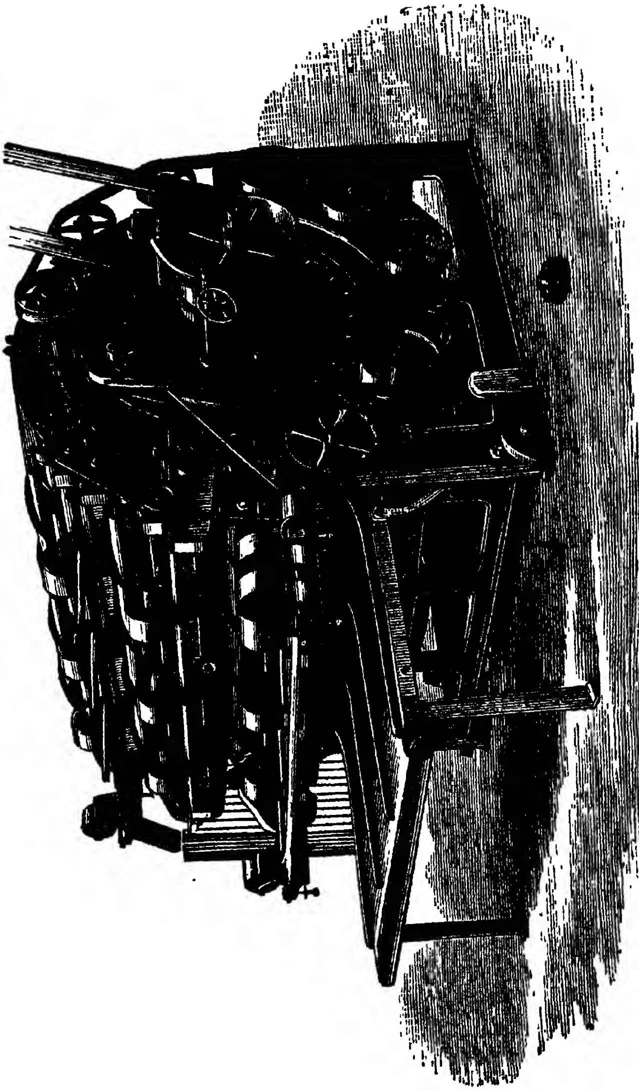
Weight in lbs. per Spl.	Leas.	Weight of 100 Spdls.	100 Spdls. Flax wasting 22 per cent.	100 Spdls. Tew wasting 25 per cent.	100 Spdls. Tow wasting 28 per cent.	100 Spdls. Tow wasting 30 per cent.	100 Spdls. Tow wasting 33⅓ per cent.	100 Spdls. Tow wasting 35 per cent.	100 Spdls. Tow wasting 40 per cent.	100 Spdls. Tow wasting 50 per cent.
15	3·2	1500	1923·07	2000	2083·33	2142·85	2250	2307·69	2500	3000
14	3·43	1400	1794·84	1866·66	1944·44	2000	2100	2153·84	2333·33	2800
13	3·69	1300	1666·66	1733·33	1805 55	1857·14	1950	2000	2166·66	2600
12	4	1200	1538·46	1600	1666·66	1714·28	1800	1846·15	2000	2400
11	4·36	1100	1410 25	1466·66	1527·77	1571·42	1650	1692·30	1833·33	2200
10	4 8	1000	1282·05	1333 33	1388·88	1428·57	1500	1538 46	1666·66	2000
9	5·33	900	1153·84	1200	1250	1285·71	1350	1384·61	1500	1800
8·5	5 65	850	1089·74	1133 33	1180·55	1214·28	1275	1307 69	1416·66	1700
8	6	800	1025·64	1066·66	1111·11	1142·85	1200	1230·76	1333 33	1600
7·5	6·4	750	961·53	1000	1041·66	1071·42	1225	1153·84	1250	1500
7	6·86	700	897·43	933·33	972·22	1000	1050	1076·90	1166·66	1400
6·5	7·38	650	833·33	866·66	902·77	928·57	975	1000	1083·33	1300
6	8	600	769·23	800	833·33	857·14	900	923·07	1000	1200
5·75	8·34	575	737·18	766·66	798 63	821·42	862·5	884·61	958·33	1150
5·5	8·73	550	705·12	733·33	763 66	785·71	825	846·15	916·66	1100
5·25	9·14	525	673 07	700	729·16	750	787·5	807·69	875	1050
5	9·6	500	641·02	666·66	694·44	714·28	750	769·23	833·33	1000
4·75	10·10	475	608·97	633·33	659·49	678·57	712·5	730·77	791·66	950
4·5	10·66	450	576·92	600	625	642·85	675	692·30	750	900
4·25	11·29	425	544·87	566·66	590·27	607·14	637·5	653 84	708·33	850
4	12	400	512·82	533·33	555·55	571·42	600	615·38	666·66	800
3·75	12·80	375	480·77	500	520·82	535·71	562·5	576 92	625	750
3·5	13·71	350	448 71	466·66	486·11	500	525	538 46	583·33	700
3·25	14 76	325	416·66	433·33	451·38	464·28	487·5	500	541·66	650
3	16	300	384·61	400	416·66	428·57	450	461·53	500	600
2·75	17·45	275	352·56	366·66	381·94	392·85	412·5	423·07	455	550
2·50	19·2	250	320·51	336·66	347·22	357·14	375	384·61	416·66	500
2·4	20	240	307·69	320	333 33	342 85	360	369·23	400	480

CARDING.

Carding is one of the most important branches in a spinning mill, and especially in the primary processes through which tow passes before reaching the spinning room. Difficult as it is to give any practical guidance in the manipulation of the flax fibre over the various machines, it is still more difficult to do so in carding. The objects in carding are various, depending on the material, and the purpose for which it is intended, *e.g.*, separating the fibre from shive, nap, and dirt; cutting the fibre; also, sorting the tow by various doffers, and delivering in a sliver for the drawing frames. In order to judge how any given tow should be carded we must have the material before us, and, knowing the yarn into which it is to be made, see the defects which it is essential to remove for that yarn, and, by an acquaintance with the qualities of our material, such as strength, &c., strive to arrange our carding so as to perform the work with the least possible damage to the fibre, and with the least possible waste.

In tows, as in flax, we have a wide range of material, from the fine, and sometimes combed, for wet-spun yarns, to the coarse, for sacking, canvas, &c. The quality of the material to be operated on differs so much that, in order to give an account of carding, we would require to give an example of the many different varieties of tows, for which we require different carding. Generally speaking, one carding is sufficient for Baltic tow, the shive, dirt, &c., being easily thrown out, owing to the dry and open nature of the material. In Scotland a great quantity of the tow worked is Baltic, hence carding is accomplished in a different manner from that adopted in the case of the finer tows in Ireland. In the majority of Scotch mills only one card is used, acting as a breaker and finisher,

and it is only in cases of very dirty tow that two separate cards are used. I shall give, farther on, the particulars of a card adapted for from 3 to 4 lbs. per spindle. The speed of the cylinder varies according to the nature of the material and the purpose for which it is intended, as does also the speed of the workers and strippers, &c. Cylinders, 6 ft. by 5 ft., generally run 150 to 200 revolutions per minute. By varying the speed of one or the whole of the strippers and workers we can throw out much or little dirt. Fast driving of the strippers under the card is liable to throw out fibre as well; but where it is essential to drive these fast for cleaning, a tin cylinder may be placed under, between the worker and stripper, allowing the shive and dirt to fall, and keeping the fibre in. Where two cards are used, the workers and strippers may be driven slower than in a single card with similar material and work to perform. Hand-made tow, such as Archangel, Kama, Jaroslav, and machine tow off the same, as well as Rjeff, are so clean that the straightening and opening up of the fibre are the principal requirements; but some of these tows, and especially those off the hackling machines, are very full of naps, and require more carding, especially if for light yarns. Some hand-made tows of this class require opening and teasing before going to the card, and this is accomplished best by manual labour or by an open teaser. The evil effects of over-carding will, however, be very readily seen in these, owing to the weak nature of the fibre. Doffing by means of a roller is applied to cards of this description, and this process differs from the mode applied to cards for fine tows, as in these doffing knives are used. In a breaker and finisher card two doffing rollers are generally used, while with two separate cards and for light sizes, such as 3 lbs., the finisher has sometimes only one doffing roller. Generally, however, the slivers from cards having two doffing rollers are delivered into one, as by taking away the best or top sliver the remaining one would be left poor,



CARD.

and the fibre very short. The principal objections to twice carding are, the greater amount of waste, the breaking up of the fibre, and the risk of ends getting away. To this has to be added the extra cost, as lapping machines or cans have to be used.

If only one card is employed, it is essential to run first through a teaser flax used as tow, codillas, rope tow, &c., for the purpose of putting it into working form for the finisher.

Setting Cards, Clothing, &c.

In setting cards the clothing required varies according to the material being worked. This is also the case with the clothing on workers and strippers. The distance of the workers and strippers from the cylinder also varies, they being set further off at the beginning than at the end, the distance depending on the length of fibre and nature of material under process. The diameter of the workers and strippers is also varied according to the length of fibre. The strippers are generally from 1 in. to 2 in. larger in diameter than the workers, so we have them running worker and stripper 4 in. and 5 in, 5 in. and 6 in., 5 in. and 7 in., 7 in. and 8 in., 7 in. and 9 in., and so on. It is a point requiring much attention that when new machines are ordered full particulars should be given, so that the machines may be thoroughly adapted for the class of material and kind of work for which they are intended.

Fine Machine Tows.

In dealing with fine machine tows, the necessity of freeing from nap and opening up is the main point. Especially in soft mill-scutched Irish tow this difficulty is great. Tow coming from a brush and doffer hackling machine is very nappy if the brush

is not set with great accuracy. These tows are mainly for good yarns. The naps in some tows may be opened up sufficiently by once carding, but, if very nappy, a great many of the naps will be drawn into hard knots, and require second carding to throw them out. In the finer tows the fibre generally is shorter, being machine and sorting tow from Irish, Flemish, Dutch, and Courtrai cutline, and to work these the workers and strippers are lessened in diameter, say to 4 in. and 5 in. and 5 in. and 6 in. respectively, a greater number being put in, increasing to 8, 9, and 10 pair on a card. Particulars of a card, for 25 lea, made from long line tows, are given at page 120, but this card must not be considered as a standard from which you get finer or coarser for finer or coarser yarn. Take, for example, one of our very coarsest tows, "re-scutched Irish," and we find that the finishing card cylinder will require to be covered with about 40 pins to the square inch, spinning say 14 to 20 lea. This tow requires a great amount of carding to free it from dirt, open the lumps, knots, &c.

Owing to the great length and matted condition in which this tow comes from the scutchers, it requires a coarse shaker or teaser. Particulars of this machine will be found at page 120. The person spreading or feeding stands on a high platform, and the tow is discharged, well shaken or teased, below this platform. Some machines of this description discharge at the back, and consequently no platform for the feeder is required. Passing through a breaker similar to the one particulars of which are also given at page 120, and coming to the finisher, we require a card a great deal finer than would be supposed from the coarse nature of the material. In order to open the naps we must have the cylinder clothed nearly as follows:—Pins No. 20 wire, $\frac{3}{16}$ in. long, 17 rows in stave, 24 in. × 3 in., which equals 40 pins per square inch, for 14 to 30 lea. For heavier numbers, wet and dry spinning, coarser cards are used.

Card Calculations.

Taking the draft on a card, or the other calculations as to the speed of the various parts, appears to a beginner, owing to the complication of wheels and pulleys, an almost impossible undertaking. However, a very short acquaintance with the machine enables one to trace to its origin the motion of any particular part, and the calculations become very simple indeed. Owing to the variety of construction, we propose giving the calculations for cards which have gearing arranged in different ways, the first card having doffing knife, with draft and other gearing mainly on one side; the second card one doffing roller, with draft gearing on one side; and the third card two doffing rollers, with gearing for draft calculation on both sides of the card.

For a card with the gearing all on one side the various calculations are comparatively easy.

Draft.—We start with the pinion on the end of the delivering boss, say with 20, which drives a stud wheel 35; on this stud a 36 wheel drives a second stud wheel 60, and on this stud a 25 pinion drives a 110 wheel on the feeding rollers. Taking the drivers and driven as in an ordinary draft calculation, and the diameter of feeding rollers 3, and diameter of delivering boss $3\frac{1}{2}$, we have—

$$\frac{35 \times 60 \times 110 \times 3{\cdot}5}{20 \times 36 \times 25 \times 3} = 15 \text{ draft.}$$

Speed of Workers.—Taking the speed of cylinders, say 200, we have this multiplied by the cylinder pinion 65, which drives a stud wheel 128, and on this stud a pinion 34 drives a second stud wheel 160, and a stud pinion 60 drives the top stud wheel 90, and stud or change pinion 25 drives worker wheels 90; which gives—

$$\frac{200 \times 65 \times 34 \times 60 \times 25}{128 \times 160 \times 90 \times 90} = 4 \text{ speed of workers.}$$

Speed of Strippers.—This is easily found by multi-

stud wheel, and stud pinion 24 drives feeding roller wheel 96.

$$\frac{180 \times 44 \times 36 \times 24}{145 \times 100 \times 96} = 4{\cdot}9 \text{ speed of feeding rollers.}$$

Calculations for Third Card.

The third description of card, namely, that with two doffing rollers, has, as already said, the draft gearing on both sides, hence the difficulty for beginners. We proceed in the same way as with the previous cards, commencing, however, on the opposite side from that on which the feeders are geared.

Draft.—Taking the pinion on the end of the top delivering roller at 22, we find it drives a stud wheel 54, and on the same stud a 22 pinion drives an 84 wheel on the bottom doffing roller. We have now to go to the opposite side, and on the same doffing roller we have an 84 wheel driving a stud wheel 72; on the same stud a 52 pinion drives a 120 wheel on the feeding rollers. The diameter of the delivering roller is 4·25, and the diameter of the feeding rollers 3·5; multiply, as before, all the driven by the diameter of the delivering roller for a dividend, and the drivers by the diameter of the feeding rollers for a divisor.

$$\frac{54 \times 84 \times 72 \times 120 \times 4{\cdot}25}{22 \times 22 \times 84 \times 52 \times 3{\cdot}5} = 22{\cdot}5 \text{ draft.}$$

To find the Speed of Workers.—Commencing with the speed of the cylinder at, say, 178 revolutions per minute, we have this multiplied by cylinder pinion 40, which drives 120 on delivering rollers, and on the opposite side of the delivering roller a 22 pinion drives a 54 stud wheel, and on the same stud 22 drives 84 on each doffing roller; then, on the same side as we started, 84 drives a 72 stud wheel, 22 stud or change pinion drives a 66 wheel on the worker, and, if the same pinions are on each

worker, they will, of course, be all at the same speed. The drivers and driven give us—

$$\frac{178 \times 40 \times 22 \times 22 \times 84 \times 22}{120 \times 54 \times 84 \times 72 \times 66} = 2{\cdot}46 \text{ speed of workers.}$$

Speed of the Strippers.—On the opposite side of the card from the workers the strippers are driven by a belt passing round a pulley on their end, which pulley is driven by a drum on the end of the cylinder; so that we have only to multiply, as in previous cards, the speed of the cylinder, 178, by the diameter of this drum, 18 in., and divide by the diameter of the stripper pulley, 14 in.

$$\frac{178 \times 18}{14} = 229 \text{ speed of strippers.}$$

Speed of Delivering Roller.—We have the speed of the cylinder, and cylinder pinion 40 driving 120 on each delivering roller, which gives us

$$\frac{178 \times 40}{120} = 59{\cdot}33 \text{ speed of delivering roller.}$$

Speed of Doffing Roller.—We might commence with the speed of the delivering roller, but, starting with the speed of the cylinder, we have cylinder pinion 40 driving 120 wheel on the delivering roller, and on the opposite side of delivering roller we have 22 pinion driving 54 stud wheel, and on the same stud a 22 pinion drives an 84 wheel on each doffing roller.

$$\frac{178 \times 40 \times 22 \times 22}{120 \times 54 \times 84} = 6{\cdot}33 \text{ speed of doffing roller.}$$

Speed of Feeding Rollers.—Instead of commencing at the cylinder pinion we will commence with the speed of doffing roller just given, 6·33, and the same side on which the feeding rollers are geared on we have 84 on the doffing-rollers driving a 72 stud wheel, and on the same stud a 52 stud pinion driving 120 on feeding rollers.

$$\frac{6{\cdot}33 \times 84 \times 52}{72 \times 120} = 3{\cdot}2 \text{ speed of feeding rollers.}$$

ARRANGEMENT OF CARD PARTICULARS.

Particulars.	Shaker or Teaser.	Coarse Breaker.	Breaker and Finisher for ·5 to 6 lb. per Spindle.	Finisher for 3 to 4 lb. per Spindle.	Breaker and Finisher for 25 Lea Warp.
Diameter of Cylinder, in feet, ...	3	4	5	4	5
Width of do., do., ...	4	6	6	6	6
Number of Strippers, ...	None	6	7	8	8
Do. Workers, ...	"	5	6	7	7
Do. Doffers, .. .	"	1	2	1	3
Diameter of Doffers, in inches, ...	"	14	14	14	14
Do. Strippers, do., . ..	"	8	8	8	9
Do. Workers, do., . ..	"	7	6¾	7	7
Do. Feeders, do., ...	2½	3½	3½	3¼	2½
Cylinder, Wood or Leather Clothing, ..	Wood	Wood	Wood or Leather	Wood or Leather	Wood or Leather
No. of Wire, Cylinder, ...	¾	13	14	17	14
No. of Wire, Strippers, ...	—	14	(1, 2, & 3) 16 (4 & 5) 17 (6 & 7) 18	1, 2, 3, 4, & 5 16 6, 7, & 8 18	1, 2, & 3 14 4 & 5 16 6 & 7 18 8 20
No. of Wire, Workers, ...	—	14	(1 & 2) 16 (3 & 4) 17 (5 & 6) 18	1, 2, 3, & 4 16 5, 6, & 7 18	1 & 2 14 3 & 4 16 5 & 6 18 7 20
No. of Wire Doffers, ...	—	14	18	18	1=18 2=18 3=20
No. of Wire, Feeders, ...	10	11	14	15	14
Pins per square inch, Cylinder, ...		7	14	27	36
Pitch of Pins or Spikes, ...	2 inches				

TOW PREPARING.

Tow preparing is a more important operation even than flax preparing, owing to the very different state of the sliver coming from the card compared with the flax sliver from a spreadboard. The remarks on flax preparing as to the proper relative speeds of the different parts of the machines apply equally to tow preparing. So also does the caution as to having the gills overloaded, &c. Owing to the short fibre in tow, naps, lumps, &c., it is an essential point to have the faller coming as close as possible to the nip of the roller, and so hold the sliver, especially short fibres, naps, &c., until taken hold of by the rollers With a long distance between the nip and fallers, naps, lumps, &c., are carried into the rove without being drawn. In order to prevent this we require smaller drawing rollers than in flax preparing; in some very lumpy or nappy tows, roving frame rollers being made as small as $1\frac{1}{8}$ to $1\frac{1}{4}$ in. diameter, to allow the faller to be brought close to the nip. It is also necessary to have as short a pin as possible consistent with the weight of the sliver, as this also tends to allow the faller to be close to the nip.

The conductors at the back of the drawing frames should be as wide as the gill will properly admit, especially at the back of the roving. The conductors at the front of the finishing drawing frame or delivering bosses should not contract the sliver much, but keep the sliver as wide as possible for the roving; and, at the drawing roller of the roving, contract the sliver suddenly, say to one-third of its width, in very nappy tows and those with a good quantity of short fibres.

In flax preparing the drafts run from say 10 to 15 on the drawing frames and roving, but in tow, owing to the much shorter fibre, &c., the drafts are much shorter,

say 6 to 8. Working very short tows, rope tow, waste sliver, card waste, &c., for heavy dry spun yarns, does better with six of a draft; while fine and sometimes combed tow, for 60 to 100 lea, will do with eight or longer. In flax preparing, again, the speed of the roving is regulated by the speed of the spindles, or rather the spindle gearing; but in tow preparing the speed of the fallers regulates the speed at which we may drive. This is owing to the much shorter draft, and 200 fallers per minute is considered a high speed for screw gills, the pitch of screws being $\frac{3}{8}$, less or more, and thus we are prevented driving up to what the spindle gearing would permit. In the very fine tow trade frequently four drawing frames are used, and generally speaking, three drawing frames for all tows for wet and dry spinning are used. However, where two cards are used, and for coarse heavy yarns, such as 6 lbs. per spindle and upwards, and for wefts, where cheap production is the main point, two drawing frames only are used; and when 40 lbs. per spindle, made out of hemp, coarse rope tow, &c., is reached, a rotary gill roving is sometimes used (no spinning frames), running 300 to 400 fallers per minute, or the spindles of a frame with $9 \times 4\frac{1}{2}$ in. bobbins, running 1200 to 1500 revolutions per minute.

Calculations for Weight of Rove.

After leaving the card, the sliver passes over one, two, three, or four drawing frames and a roving frame, as the case may be, and the next point to consider is the making of the rove the required weight. In the fine trade weighing the tow in certain quantities, and spreading on a certain length of the feeding sheet of the card, then a bell on the first drawing, and setts put up at the back of the second drawing, is the plan generally adopted. Another mode is, spreading on the card without weighing, and having a bell on the card and one on the first drawing, thus having double sett weights. However, in the Scotch trade for heavy yarns the clock

system is generally used, spreading to the regulated motion of the clock, sometimes with and sometimes without a bell on the first drawing frame. Spreading on the card by weight is sometimes used without the sett weight for heavy yarns. The same remarks apply here regarding the sett and clock systems as in the case of "Flax Preparing." Indeed, the reasons against using the clock system, or even weighing the tow to the card without a sett weight at the first or second drawing frame, are more numerous. If, for instance, you have a breaker as well as a finisher, and the clock on the breaker, the sliver being put into a lap for the finisher, you have the extra risk of ends being away without any check on proper slivers being delivered from the finisher card. Besides, if the tow varies much, so does the rove, and likewise the yarn. It is a matter for consideration in what way the sett should be placed. If the sliver from the card is light, and requires too many ends to go into one at first drawing, it may be better to weigh at the second, &c. Again, if your cans are not so numerous at the back of first drawing, you may have bell on the card. In order to save weighing at the card, a clock is sometimes put on, and setts made up afterwards. If in heavy yarns, say about 16 lbs. per spindle, it is found inconvenient, and perhaps too expensive for the material used, to weigh either at the card or in setts, some other means of checking the clock should be applied. Knowing the required weight of rove with the drafts, and doubling on the drawing frames, we have to find the sett weight, then the weight of material to be spread on the card per yard; or, if a clock be used, the quantity to be spread in each revolution of the hand of the clock: or, if the speed of the clock be altered, the number of yards required in one revolution. The manner in which to find the sett weight is fully explained in "Flax Preparing"; so also is the way in which the amount is increased or reduced owing to the variations of waste and bulking, so that we need not repeat these details here.

Having settled the weight we require 100 yards of

rove to be, then, by calculation (see "Flax Preparing"), suppose we find the weight we require at the front of the first drawing or bell frame to be 500 yards weighing 10 lbs. If we have a draft of six on the first drawing frame, and eight ends running into one, we have $\frac{10 \times 8}{6} = 13\frac{1}{3}$ lbs. This $13\frac{1}{3}$ lbs. is the weight of 500 yards of sliver delivered from the card. Knowing the draft, and estimating the waste according to the material, &c., we can find the weight to be spread on any given distance of the feeding table of the card. Before going farther, however, I may explain that adding the waste made by carding in the ordinary way will not be correct. If, for instance, in the present case we have 15 per cent. of carding waste, and require to know the amount to be spread which, less, 15 per cent., will equal $13\frac{1}{3}$ lbs., we must, instead of simply adding 15 per cent. to $13\frac{1}{3}$ lbs., find it in the following way:—

Rule for finding amount which, after deducting a given percentage, equals a given amount.—Deduct given percentage from 100 and divide it into given amount multiplied by 100.

If, for instance, we have 100 lbs. tow, carding waste 20, amount delivered 80 lbs., adding simply 20 per cent. to 80 lbs. will not give us the original amount, 100 lbs., but we must find amount according to preceding rule.

Example.—As an example we may continue the foregoing calculation. Having a sliver $13\frac{1}{3}$ lbs. per 500 yards, and supposing there will be 15 per cent. waste on the card, we must ascertain the amount required in 500 yards before carding $\frac{13{\cdot}33 \times 100}{100 - 15} = 15{\cdot}7$ lbs. This 15·7 lbs. must now be multiplied by the draft on the card, say 25, this is $15{\cdot}7 \times 25 = 392{\cdot}5$ lbs. per 500 yards, which divided by 500 gives 12·56 oz. per yard to be spread on feeding table.

Clock System.

Take two cards, a "Finisher" and "Breaker with Clock" Weight required at the front of first drawing frame same as last, 10 lbs. per 500 yards, and, with the same doublings and drafts, we have the same weight of sliver to be delivered from the finisher card, $13\frac{1}{3}$ lbs. per 500 yards. Supposing we have 8 per cent. waste on this card, and proceeding as in the last case, we have—

$$\frac{13\cdot33 \times 100}{100 - 8} = 14\cdot5 \text{ lbs.}$$

Draft on the card 20, and, say, 24 slivers in the laps at the front, $\frac{14\cdot5 \times 20}{24} = 12\cdot1$ lbs. weight of 500 yards of sliver from breaker. Supposing the waste on the breaker to be 12 per cent. we have, $\frac{12\cdot1 \times 100}{100 - 12} = 13\cdot75$ lbs., the quantity to be spread for 500 yards delivered. A certain unchangeable quantity of tow, say 50 lbs., may be suspended from a balance. The clock being driven from the delivering roller, we must ascertain the number of yards to be delivered in one revolution of the clock during which the 50 lbs. is spread. $\overset{\text{lbs.}}{13\cdot75} : \overset{\text{lbs.}}{50} :: \overset{\text{yds.}}{500} = 1818$ yards in one revolution of the clock during which 50 lbs. of tow is spread.

Clock Motion.

This has already been described in "Flax Preparing." A simple arrangement for a card delivering with a roller is a worm on the end of the roller driving a pinion, say 70, on the end of an upright shaft, and on the opposite end a worm driving the change pinion, which carries the hand on the dial. With a roller, say, 11 in. circumference, and an 85 change pinion, we have $\frac{11 \times 70 \times 85}{36}$ = 1818 yards in one revolution. As previously explained,

a clock may be placed on the card where only one is used, acting as breaker and finisher. If rotaries are on the card, that have a short draft, say three or four, this must be taken into account in the foregoing calculations, and where we multiply by card draft we must also multiply by the draft on the rotaries. A new weight of rove being required, and spreading the calculated weight at the card according to supposed waste, it may be found that the sliver, on weighing it, comes out too light or too heavy (care should be taken to weigh the sliver when the card is at full speed); in this event, place a little more or a little less weight on the spreading sheet per yard, or, if spreading to a clock, alter it accordingly. Supposing, however, you have not room between the feeding rollers for a heavier spread without choking, then alter the draft of the card. This, of course, has rarely to be done if the card is adapted for its work. The quantity done per day varies from five to thirty-five cwt., and the waste from five to thirty-five per cent. The speed of the doffing roller, if a doffing knife is used, depends on the speed of the latter, and if the doffing knife is driven too slow the tow is likely to lap up and be taken on to the cylinder again; if too quick, it is apt to break and require incessant attention. They run generally 300 to 400 strokes per minute, but an eccentric doffer with a short stroke will run, say, 1000 strokes per minute, and is now put on the finer cards. Doffing rollers, as in the Scotch trade, must be used instead of doffing knives where there is a heavy load or very dirty tow. On almost all cards for the finer tows, down to say three to four lbs. per spindle, we have rotaries placed on the end of the conductor plate, with rotary gills through which the tow passes before going into the can. This greatly improves the sliver before going to the drawing frames. Rotary gills are commonly driven about 300 per minute, $\frac{2}{3}$ in. pitch, which gives 200 in. per minute.

WET SPINNING.

In spinning, the rove after leaving the preparing is reduced by drawing into the required size. Among the first things an overseer requires to know is how to put any given draft and twist on his frames. Now, in spinning rooms where the draft and twist are changed so often, a draft and twist constant number is found for each set of frames, and, by dividing your draft into your draft number, and twist required into your twist number, you have draft and twist pinions to go on. These numbers are variously named constant numbers, standing numbers, gauge points, &c. We will first show how to find the draft.

Rule to find Draft.—Multiply the drawing roller pinion by change pinion, and again by the diameter of retaining roller for a divisor, and for a dividend multiply stud wheel by wheel on top roller and by diameter of drawing roller.

Example.—Thus, a frame with drawing roller pinion 20, stud wheel 60, change pinion 30, wheel on end of retaining roller 60, diameter of top roller $1\frac{1}{2}$ in., diameter of drawing roller 2 in.

$$\frac{60 \times 60 \times 2}{20 \times \underset{\text{Ch. pin.}}{30} \times 1\frac{1}{2}} = 8 \text{ draft.}$$

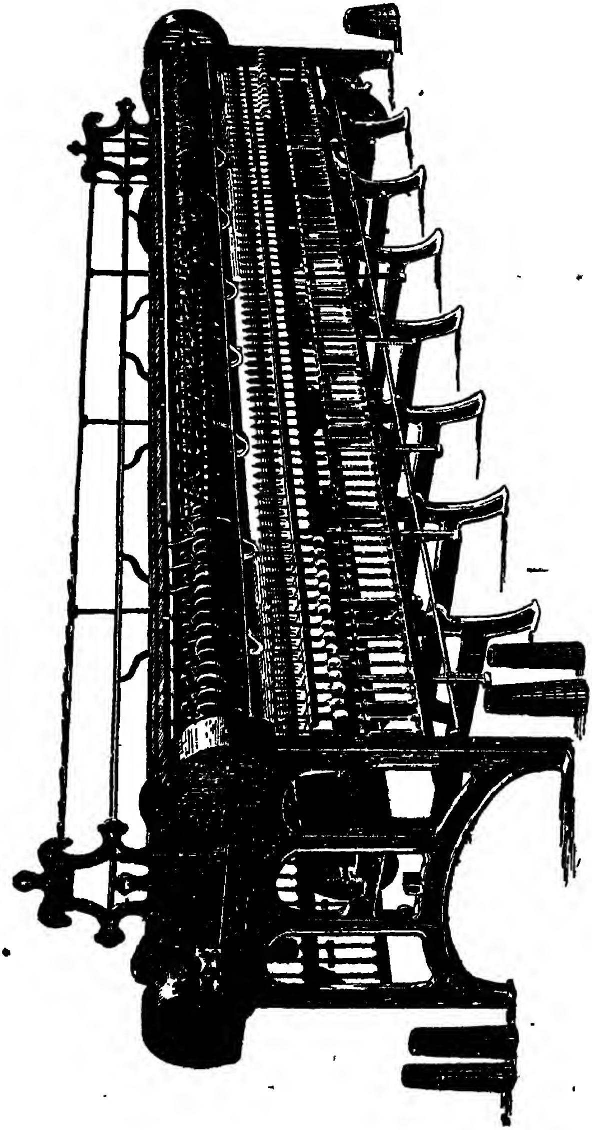
To obtain standing draft number, you leave out the change pinion, thus—

$$\frac{60 \times 60 \times 2}{20 \times 1\frac{1}{2}} = 240 \text{ standing number.}$$

Now, by dividing any draft you require into 240, you will find change pinion—thus, for 8 draft we have $\frac{240}{8}$ = 30 change pinion. Of course, you will not always, by dividing your draft into standing number, find an

exact number of teeth, but an acquaintance with your frames and yarn will soon tell you whether you require a little more or less. Now, in order to thoroughly understand this rule, you must know by what means it is found; and, if the same method is followed out of finding the reasons for such rules as draft, speeds, &c., we will then be able to take the speed of any particular part of any machine, or other calculation, although having no rule and no acquaintance with the machine. Let us follow out the draft calculation. Draft is the excess plus 1 in length delivered by the drawing roller over that taken in by the top or retaining roller. Suppose both rollers are 2 in. diameter, and the drawing roller speed equal to 10 revolutions for every one revolution of retaining roller, we have then ten of a draft; now, take the speed of the drawing roller at 100, drawing roller pinion 20, stud wheel 60, change pinion 30, top roller wheel 60, diameter retaining roller $1\frac{1}{2}$, diameter drawing roller 2.

First, we have the speed of drawing roller 100 multiplied by circumference of drawing roller $2 \times 3{\cdot}1416 = 6{\cdot}283 \times 100 = 628{\cdot}3$, amount delivered by drawing roller. We have now to find amount taken in by top roller, and first we find its speed. Speed of bottom roller 100 multiplied by drawing roller pinion 20, which is a driver, divided by stud wheel 60, which is a driven, multiplied by change pinion 30 driver, and divided by top roller wheel 60, which is a driven, and we have $\frac{100 \times 30 \times 20}{60 \times 60} = 16{\cdot}66$ speed of top roller. Now, the speed of the top roller multiplied by its circumference ($1{\cdot}5 \times 3{\cdot}1416$) $= 4{\cdot}71$ circumference, would equal the quantity it takes in, $16{\cdot}66 \times 4{\cdot}71 = 78{\cdot}46$ quantity taken in. If we divide the quantity delivered by the quantity taken in, we have draft $\frac{628{\cdot}3}{78{\cdot}46} = 8$ draft. Now, let us take our multiplicand, and we get $\overset{\text{r p.}}{20} \times \overset{\text{c. p.}}{30} \times \overset{\text{cir. of top roll.}}{4{\cdot}71}$ and divisor, $\overset{\text{stud wheel}}{60} \times \overset{\text{top roller wheel}}{60} \times \overset{\text{circumference of drawing roller}}{6{\cdot}28}$ which gives us our rule.



FRAM

In the rule the diameters of the rollers are used, whereas in following out the rule we have used the circumference for clearness. The diameters would have attained the same result, because in finding the circumference of each roller you multiply by the same number. In the same way, multiplying the diameters by any other number than 3·1416 would have attained the same result; and, further, multiplying by 3·4 is the correct method for finding the circumference of fluted rollers, as explained farther on.

Supposing you require in some exceptional case to put on a draft either longer or shorter than usual, and have not suitable change pinions, you will require to change some of the other pinions in draft gearing, and the drawing roller pinion is generally changed in such cases. Say, for example, your standing number is 240, and you wish a draft of 12. This would give you a change pinion $\frac{240}{12} = 20$. Your drawing roller pinion is 40, so that in finding your draft, 40 and 20 are multiplied together. Not having got a 20 change pinion, put on one that you have, say 25 change pinion. In order to keep the proportion, 25 multiplied by the new drawing roller pinion to go on should equal the original drawing roller pinion by the original change pinion 20, so that $\frac{40 \times 20}{25} = 32$, the new drawing roller pinion to go on, and it may be seen that the first pinions $\begin{matrix} \text{d.r.} & \text{ch.} \\ 40 \times 20 \end{matrix} = \begin{matrix} \text{d.r.} & \text{ch.} \\ 32 \times 25 \end{matrix}$ the make-shift pinions. In a similar way you could alter the stud or top roller wheel.

A most important point to be arrived at is to have all the draft change pinions the same pitch and diameter of socket, and the larger and finer in pitch the better. The same remark applies to twist change pinions.

Twisting.

Twisting is the next thing that is required. Twist means the turns put on the yarn as it is delivered

from the drawing roller by the spindle. Thus, if the spindles are running at 3000 revolutions, and the roller delivering 300 inches per minute, we have $\frac{3000}{300}$ = 10 turns or twists of the spindle for every inch delivered.

Rule for finding the Twist.—Multiply the diameter of cylinder by stud or twist wheel by drawing roller wheel for dividend, and divide by cylinder pinion, multiplied by change pinion, multiplied by diameter of warve, multiplied by circumference of drawing roller.

Example.—Stud 120, cylinder pinion 30, drawing roller wheel 120, warve 1 in., cylinder 12 in., change pinion 48, circumference of drawing roller 8 in.

$$\frac{120 \times 120 \times 12}{30 \times 1 \times 48 \times 8} = 15 \text{ turns per inch.}$$

To ascertain at once what change pinion is required, given the number of turns wanted, a standing number is obtained in the same way as for draft by leaving out the change pinion; thus—

$$\frac{120 \times 120 \times 12}{30 \times 1 \times 8} = 720 \text{ standing number.}$$

Now, if fifteen turns are required, we have $\frac{720}{15}$ = 48 change pinion. Let us see how this is obtained. First, take the speed of the drawing roller. Suppose the cylinder pinion runs at 300 revolutions, then we have 300 multiplied by cylinder pinion and multiplied by change pinion, and divided by stud wheel multiplied by drawing roller wheel.

$$\frac{300 \times 30 \times 48}{120 \times 120} = 30 \text{ speed of drawing roller.}$$

The speed of drawing roller multiplied by its circumference 8 = (30 × 8) 240, number of inches delivered per minute. Now, take the speed of spindles, multiplying speed of cylinder (which is the same as cylinder pinion), 300, by diameter of cylinder, and divided by diameter of warve. $\frac{300 \times 12}{1}$ = 3600 speed of spindles. If we

have 240 inches delivered, and turns of spindle 3600, by dividing inches into turns we have turns per inch $\frac{3600}{240} = 15$ turns or twists per inch.

Now, by going over this calculation we can pick out what are used as divisors, and what as dividend, and thus form our rule.

Circumference of Fluted Rollers.—In taking the twist we require the circumference of the drawing roller, and in finding this from the diameters we must depart from the ordinary rule and make allowance for the extra length of the circumference caused by the flutes. It is found near enough for practical use, and adopted by spinners, by multiplying the diameter of the fluted roller by 3·4 for its circumference.

Draft from Lea and Weight of Rove.

The next thing required is to find what draft is required for any size, having got the lea and weight of the rove. There are a great many ways of arriving at this. In some places the weight of 100 yards of rove is the standard from which the draft required is ascertained. In other places 200 yards or more, and in some places the number of yards of rove in a given weight is used. It matters little which way is used, provided you are able to bring the yarn out the proper weight. In the rules used there is a certain quantity allowed for waste and contraction by twist, and overseers by a little practical experience know how much must be added to their draft in order to bring out the right weight. Annexed is a very simple rule. Of course we do not mean to say that this rule will do for all places, as it depends on whether you have warp or weft yarns—in other words, much or little twist, clean or dirty yarn—to deal with to regulate the allowance.

Rules to find Draft, Leas, or Weight of 100 *yards of Rove, any two of these being known.*—To find draft, weight

of 100 yards in drs. being given, multiply weight of 100 yards by leas required and divide by 85·3.

Example.—Weight of 100 yards is 12 drs., to find draft for 50 leas.

$$\frac{50 \times 12}{85 \cdot 3} = 7 \text{ draft.}$$

As the foregoing rule makes no allowance for the increase in weight of the yarn owing to contraction by twist, a certain amount must be added to the draft thus obtained, the amount varying with the twist the yarn requires.

The following is a very handy rule, giving the draft with an addition of 7 per cent., which is near enough for ordinary purposes.

Rule to find Draft with 7 per cent. added.—Multiply weight of 100 yards in drs. by leas required and divide by 80.

Example.—Weight of 100 yards is 12 drs., for 50 leas.

$$\frac{50 \times 12}{80} = 7 \cdot 5 \text{ draft.}$$

Let us see the reason of these rules. In the preceding example we have 12 drs. per 100 yards, and in 300 yards, which equals one cut, we will have 36 drs. Now, we require 50 leas, and in 50 leas or cuts we would have $36 \times 50 = 1800$ drs., that is of rove, but only 256 drs., or 1 lb., is required for 50 lea yarn. Therefore we must draw it out the number of times that 256 is contained in 1800. We thus have

$$\frac{1800}{256} = 7 \text{ draft.}$$

Placing the foregoing in the form of a fraction, we have

$$\frac{300 \times 12 \times 50}{100 \times 256}$$

by contraction we have

$$\frac{12 \times 50}{85 \cdot 3} = 7 \text{ draft, which gives us the first}$$

rule, that without allowance for contraction by twist; and in order to obtain a draft longer by 7 per cent. we

deduct this percentage from 85·3 and obtain 80, thus having

$$\frac{12 \times 50}{80}$$

which gives us the second rule, that is, with an allowance of 7 per cent.

Rule to find the Weight of Rove, draft, with 7 per cent. allowed for twist, and leas being given.—Multiply draft given by 80 and divided by leas.

Example.—7½ draft for 50 leas, to find weight of 100 yards rove.

$$\frac{7 \cdot 5 \times 80}{50} = 12 \text{ drs.}$$

Rule to find Weight of Rove, draft, without allowance for twist, and leas being given.—Multiply draft given by 85·3. and divide by leas.

Example.—7 draft for 50 leas, to find weight of 100 yards rove.

$$\frac{7 \times 85 \cdot 3}{50} = 12 \text{ drs.}$$

The reason is, if 50 leas weigh 256 drs., or 1 lb., the rove would weigh 256 × 7 draft = 1792, that is, 50 leas or cuts = 1792 drs., and 50 leas = 300 × 50 = 15,000 yards, and if 15,000 yards = 1792 drs., 100 yards = 12; thus,

$$\frac{100 \times 256 \times 7}{300 \times 50}$$

by contraction we have $\frac{7 \times 85.3}{50}$ = 12 drs. per 100 yds.

Rule to find Leas, having weight per 100 yards, and draft with 7 per cent. allowed for twist.—Multiply the draft by 80 and divide by the drs. per 100 yds.

Example.—100 yards = 12 drs. and 7½ draft.

$$\frac{7 \cdot 5 \times 80}{12} = 50 \text{ leas.}$$

Rule to find Leas, having weight per 100 yards, and draft, without allowance for twist.—Multiply draft by 85·3 and divide by drs. per 100 yards.

Example.—With 100 yards = 12 drs., and 7 draft,

$$\frac{7 \times 85 \cdot 3}{12} = 50 \text{ leas.}$$

The reason is, having 12 drs. in 100 yards, we have 36 drs. in 300, or one cut. Now, by dividing 36 drs. into 256 drs. in a lb., we have leas in rove, but this is drawn 7 times, so we have $\frac{100 \times 256 \times 7}{300 \times 12}$; by contraction we have $\frac{85 \cdot 3 \times 7}{12} = 50$ leas.

It will be seen that the foregoing rules are based on the following proportion:—

As 85·3 (or 80) : leas :: drs. per 100 yards : draft.

As indicated in reference to Preparing, a handy rule to remember is, that twice the leas in yards of rove per oz. equals 9·38 spinning draft without allowance for twist. For 50 leas, $50 \times 2 = 100$ yards of rove per oz. to give 9·38 spinning draft. This may be proved by rule for finding draft already given. To this draft we must add the supposed contraction by twist; for example, adding 7 per cent. to $9 \cdot 38 = 10$ draft, and this is exactly the same as found by the rule previously given for finding draft from weight per 100 yards with 7 per cent. added; thus, 1 oz., or 16 drs. per 100 yards for 50 leas.

$$\frac{16 \times 50}{80} = 10 \text{ draft.}$$

We give a table with the different percentages added to 9·38 draft, showing the drafts with these different percentages for twice the lea in yards per oz.

Draft, the Number of Yards per oz. being equal twice the Lea.

Without addition.	With 4 per ct. added.	With 5 per ct. added.	With 6 per ct. added.	With 7 per ct. added.	With 8 per ct. added.	With 9 per ct. added.	With 10 per ct. added.	With 12 per ct. added.
9·38	9·75	9·84	9·94	10	10·13	10·22	10·31	10·5

Example.—50 lea would require 100 yards of rove per oz. with spinning draft of 9·38 without allowance for twist; 9·75 with 4 per cent.; with 5 per cent., 9·84; and so on. 20 lea would require 40 yards of rove per oz. for 9·38 draft without allowance, with 4 per cent. 9·75, &c.

If for 50 lea we require to add 7 per cent. for twist, by foregoing table this gives a draft of 10, but if we wish draft of 11 we can find the required yards per oz. by proportion. If 100 yards per oz., being twice the lea 50, gives 10 of a draft, how many yards per ounce shall we require to give us 11 draft?

11 : 10 : : 100 = 91 yards rove per oz. to give draft of

8 : 9 38 . 40 = 46 yds 11 for 50 lea, 7 per cent. being allowed for contraction, &c.

Similarly we find that $1\frac{1}{2}$ times the lea in yards of rove per oz. equal 7·5 spinning draft for that lea, and $2\frac{1}{2}$ times the number of yards rove per oz. equals 12·5 spinning draft for that lea. Both of these, like 9·38, are without addition for twist contraction.

SPINNING REACHES.

We now come to deal with by far the most important work in the spinning room, viz., the setting of reaches. Reach, as the word indicates, means the distance between the centres of the two rollers, otherwise the distance between the points where the material is taken in and delivered or drawn. The reaches require constant and careful supervision. Of course you cannot have a well made yarn from a badly made rove, but you can very easily spoil a well made rove by a badly adjusted reach, and even with the worst made roves you can by a properly adusted frame make the best possible yarn; thus carrying out the old maxim, make the best of the things you have got. Before proceeding further, let me explain how to find what reach a frame has at any given time.

Rule.—Add half the sum of the diameters of both rollers to the distance between the rollers.

Example.—A frame has drawing roller diameter $2\frac{1}{2}$ in., retaining roller diameter $1\frac{1}{2}$ in., and distance between $\frac{1}{2}$ in.; thus $2\frac{1}{2} + 1\frac{1}{2} = 4$, divided by $2 = 2$ which $+ \frac{1}{2} = 2\frac{1}{2}$ inch reach.

The manner in which reaches are changed is by raising or lowering the top roller the distance required, having a square piece of wood the proper thickness to fit between the two rollers as a gauge. The way to find the thickness of gauge required for any given reach.

Rule.—Take half the sum of the diameters of the two rollers from the length of reach required and the remainder equals the size of gauge or distance

between rollers. Thus, diameter of rollers equals $2\frac{1}{2}$ in. and $1\frac{1}{2}$ in., and required $2\frac{3}{4}$ reach—

$$\underset{\text{Rollers.}}{\frac{2\frac{1}{2}+1\frac{1}{2}}{2}} = 2;\ \underset{\text{Reach required.}}{2\frac{3}{4}} - 2 = \tfrac{3}{4} \text{ in. gauge.}$$

Overseers, for the sake of convenience, should have a table showing at a glance the distance required between the rollers for any given reach for each set of frames.

We give below a sample of a table, and each overseer can make a similar one, and so be able to tell the required distance without constantly repeating the same calculation.

REACH.

No. of Frames, 1 to —; Diameter of Rollers $2\frac{1}{2}$ and $1\frac{1}{2}$.

Reach,........	$2\frac{1}{4}$	$2\frac{5}{16}$	$2\frac{3}{8}$	$\frac{7}{16}$	$2\frac{1}{2}$	$2\frac{9}{16}$	$2\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{3}{4}$	$2\frac{7}{8}$	3
Distance,.....	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$	

In dry spinning the reach remains always the same, the fibre being drawn in some cases the whole length; whereas in wet spinning, after coming through the hot water trough, it is stuck together, so that it depends on the strength and size of yarn to be made how far it will draw.

There are a few suggestions we may give as to setting the reach exactly at the right length. Now, with every yarn spun, whether it be of long or short draft, well or ill prepared, strong or weak material, &c., there is a certain reach at which you will make the best possible yarn under the circumstances. Too long a reach gives an uneven thread, with small parts in the thread, and exactly the same thing occurs if your reach is too short. The more your reach is too long or too short the worse are the small parts. Now, the difference between the

smalls of a long and short reach is this. The smalls made by a reach too short are nipped in appearance, of short length, and occur very often along the thread; whereas in too long reaches you have the small parts longer, but not so many of them. Now, it is very easy to detect these inequalities or smalls, and with a very little practice you can determine whether your reach is too long or too short, or, considering all the other circumstances, as near right as you can make it. We do not wish to be understood to say that if your yarn is uneven your reach will make it right, because, though you have everything you could wish in making a yarn, still you will find smalls, although they should be reduced to a minimum. We may take it for granted that the more even the yarn is the stronger it will be, and, at the same time, an uneven yarn made by a too long reach is stronger than an equally uneven yarn made by a too short reach. Again, it is possible to have bad yarn which no movement of the reach will make better, and in that case you have to look to some other cause for the mischief. The way in which we have been accustomed to look at the evenness of yarn is when it is just off the reel, and consequently wet. You require good light—in fact, one should have a particular place whence to take the yarn to be examined. This place should be lighted from the roof and side. Standing with your back to the light, hold the hank, with the assistance of another, and examine the threads one by one, running your finger and thumb along, thus feeling as well as seeing the imperfections. The hank should be held almost close to the side of the room opposite the light, and the wall opposite the place where you hold the yarn is better to be black, thus making the light more effectual. Overseers who are not able to have hanks at their disposal can examine the yarn from the bobbin in the same way, although the hank is to be preferred. In examining yarn, after being dried for the purpose of comparison with other samples of the same number and quality of yarn spun previously, we prefer having a white background with a side light, and

are thus enabled to see distinctly the various imperfections. The importance of reaches makes me anxious to impress the necessity of having them exactly right. In 60 lea, for instance, let us suppose you are making a fairly level yarn, and your reach is at the best length. Raise one frame $\frac{1}{16}$ in., and lower another $\frac{1}{16}$ in. From the three yarns you could not be mistaken, after a little practice, in picking out each separately. That reaches do not receive the attention they require from a good many we are well aware. In some places they are rarely altered, notwithstanding that the yarns are constantly changing. It is absurd to think of spinning indiscriminately warps and wefts, &c., with the same reach. Even with the same lea, class, &c., you will, owing to change in the flax, have to vary. Let us now see how we may be able to judge from the working on the wet spinning frame. If you are working heavy numbers you will be able to feel the tension between the drawing and retaining rollers. If fine numbers, and so short reach, you will require to put your finger under the axle of the roller, and in very short reaches to judge from the yarn solely. In feeling the tension you first do so close to the top roller. Now, let us, for example, suppose you have got a proper weight of rove, and consequently a proper draft (we will consider draft afterwards), and that you are making 30 lea yarn weft. On pressing the rove back with your thumb several times you will feel, of course, the operation of drawing. If, on moving the rove backwards and forwards, that is, moving the sliver as close as possible to the top roller, you feel little or no tension, that would be too long reach; while, on the other hand, if you feel a severe tugging that would be too short reach. In order, therefore, to have a satisfactory result it is necessary to have a firm, steady pull. Of course the strength of the pull, so to speak, depends on the strength and size of the yarn, not, as might be supposed, the stronger the material the stronger the pull; but the reverse, the weaker the material the stronger the pull, owing to its brittle nature, and, we may add,

the finer the yarn the stronger the pull in comparison to its size. With the same lea, but a better yarn, you should have it easier, and so on; the stronger your material the easier you should feel with the same lea, which implies lengthening the reach the better yarn you are making. Reaches vary more in length in low numbers, because a variance of a certain number of leas in low numbers gives a greater difference in the size of threads than a similar difference of leas in finer numbers, and commonly a greater difference in the strength of the material drawn. Take, as an example, a very weak weft, say 30's, made from Riga flax, you may require a $3\frac{1}{4}$ in. reach, and in 25's, the same class of weft, with a little decrease in quality, but the same flax, and not much decrease in strength, you require $3\frac{3}{8}$, or a shade more, say $3\frac{7}{16}$. Taking a 60's weft, and suppose it requires only $2\frac{3}{4}$ in. reach, with a mixture such as this, one-half Irish, one-fourth Pernau, and one-fourth Riga, and coming down 5 lea, as in the last case, we have 55 lea weft, in this case the probability is that the reach will not require altering, beaause the size of thread is only one-twelfth heavier. In the last case 25's is one-sixth heavier than 30's; and, again, the strength of material, although changing little between 30's and 25's, changes less between 60's and 55's.

Again, between 60's and 50's it is mainly the size of the thread that has to be taken into account, and, the difference in this case being considerable, the reach will have to be lengthened. There will be little difference in the strength of the material, about one-eighth of an inch being sufficient; but if the flax in 50's is much weaker than the flax in the 60's it will counteract the longer reach which we would have allowed for the increase in size of the thread. Taking now 40 lea yarn and commencing at the poorest weft, and also four other yarns the same lea, and rising in quality, which we shall call respectively Nos. 1, 2, 3, 4, and 5, we shall compare the different reaches, each number having the same draft, but varying in the flax making them. Taking No. 1 as a very poor yarn in strength, and a mixture of two-thirds

Riga and one-third Pernau, a reach of 2¾ will be sufficient, although we have seen 40's similar to this one-eighth or one-fourth inch more. No. 2, with a mixture of one-fourth Irish, one-fourth Pernau, one-half Riga, we may safely say, will require a 3 inch reach. In No. 3 mixture, one-half Irish, one-fourth Pernau, one-fourth Riga, we have an increase of the proportion of Irish and a decrease in Riga, and the reach will be 3¼ in. In No. 4 mixture, three-fourths Irish, one-fourth Pernau, we increase in strength and length of reach to 3½ in. No. 5 is a mixture of Irish, and has a reach 3¾ in. As the increase in strength here may not be so great, less than this may do better. We would naturally suppose that the last, No 5, would be very strong material, and this yarn, which we may suppose to be a very superior warp, will, in all likelihood, increase more in quality than in strength; and if this is the case we may only require one-eighth inch increase, but if it increases greatly in strength we will require possibly 3⅞ in. With these mixtures we have given a regular advance of one-fourth of an inch, but as it depends solely here on the flax, a practical knowledge of that material requires to be displayed; but, judging only by what improvement we would expect in the yarns by the different sort of flax named, and the proportion in the mixture, the increase in reach is what we would anticipate. While No. 3 has one-half Irish, and No. 2 one-fourth Irish, the Irish in No. 3 will also be a higher sort or quality, which may also add to its strength. It is also quite possible, although not usually done, to advance a class in the lower numbers, and still increase very little in strength. In low qualities it will be seen changing from one class to another requires greater difference in reach. Again, a great quantity of wefts are made having strength as the principal object, and these would require longer reach, of course, but would be rougher yarn, supposing they are at the same cost as the cleaner ones given above. As the yarn becomes finer the reach diminishes, 90 to 120 lea weft having 2¼ in. to 2⅛ in. reach, &c.

Reach and Draft.

Having a certain draft and suitable reach, you cannot then make any considerable alteration on the draft without altering the reach. Supposing you are spinning 20 lea Line yarn with a draft of 7, the rove weighing 28 drs. per 100 yards, and, say, requiring 3½ in. reach, and making a good level yarn. If you spin 25 lea out of the same rove you require 8¾ draft, and you will find that with the same reach you will now very probably make an uneven yarn. In order to make the yarn as level as possible you will require to alter the reach and reduce the weight of rove.

Improperly or unevenly cut or hackled flax requires the reach to be short. If the fibre is too large for the lea making, you cannot have the reach as long as the strength of the flax would otherwise warrant, because these large fibres allow the roller occasionally to draw more than the proper quantity, and with a long reach would thus make smalls, whereas a little shorter reach counteracts this to a certain extent; neither of the two under the circumstances will make a good yarn, for the following reason:—The reach, to suit the heavier part of the thread caused by the thick fibre, would be too long for the small part of the thread, and hence you must set your reach, so to speak, between the two, but even this will make an uneven pull.

From the foregoing an idea may be formed of the importance of studying draft in connection with reach. We cannot make a hard and fast rule as to either the amount of draft or length of reach, and the overseer must find out for himself, judging from the material and lea, with the assistance of what has been already stated, what combination of draft and reach makes the best yarn. It should be borne in mind that practically the best amount of draft is that which does not, by being shortened, make any tangible improvement in the yarn, the strength of

material with a suitable reach being sufficient to cause it to draw as evenly as it would do with a lesser draft.

Taking, for example, a rove which requires eight of a draft for, say, 50 leas weft, if we diminish the weight of rove so that it requires seven of a draft, the rove will now in all probability require so much more twist as to necessitate a longer reach than the strength of material will allow, hence the evenness of the thread will be deteriorated, as well as costing more for preparing. Putting it theoretically, set your reach with a very short draft, increase your draft until the increase commences to deteriorate the levelness of the yarn through want of spinning quality in the material, then stop, and you have the longest draft consistent with the making of the most level yarn. Although theoretical, this may serve as a guide to results from practical experience. We have seen repeatedly spinners who worked with long drafts, on finding that they could make a much more even yarn by shorter drafts, run to the other extreme of extra short drafts. Now, what we want to show is, that after coming to a certain point, even suppose you may gain a very little, it does not compensate for the extra cost of preparing. At the same time, the opposite system of too long drafts is equally bad. Taking the 40's weft, No. 1, given before, some might think that here is a yarn requiring a very short draft, but, from our experience, a draft of nine will make a better yarn and spin than any other, more or less, and you can have a longer draft on this weft than you should have on a warp of the same size. One of these reasons is, that the amount of twist required to be put on the weft rove on account of its weakness is too great with a rove giving seven to eight of a draft, and this defect is partially got rid of by a heavier rove.

Tow Yarns.—In tow yarns the reaches vary in the same way as in the flax, but, as will be understood, they require less draft and reach.

Hard Twisted Roves.

In tow the tendency to twist the roves too hard is greater than it is in flax. At the same time, tow, owing to the short fibre, requires more twist than flax. The evil caused by too hard twisted roves is similar to that produced by a too short reach. If your reach is right for an ordinary twisted rove, it will be too short if the rove is twisted harder, as the fibres break at the point where the rove is untwisted; and hence, although it is not to be recommended, the rove is sometimes twisted harder when the reach is too long in order to avoid changing the reach.

Oiling.—Having now settled the reaches, and shown the manner in which to obtain the most level and consequently the strongest thread standing the greatest speed, throwing off the greatest production with the least possible waste, it remains to be pointed out that these results may all be discounted if the overseer does not keep his machine in proper working trim. You may not see so readily the evil effect if you have a very strong thread and heavy number that will stand any amount of rough usage, but with all yarn nowadays, and especially with fine numbers and wefts, you require to have everything going smoothly. Little things play an important part, of which we shall give a few examples. The great object, as we said, is the largest production with the least waste, with a good thread, free from working imperfections, such as bad piecings, &c. We are strongly opposed to fast driving simply for the purpose of a large production or "turn off," if this is obtained by making an unnecessary amount of waste, through the yarn breaking, &c. The most profitably worked concerns do not push for more "turn off" than can be obtained with an amount of waste unavoidable under any circumstances, and regulate the speed of their spinning machinery accordingly. The overseer must know the different causes which affect the spinning, and hence the yarn. We know of

no more common cause of yarn spinning badly than improper oiling. The axle of the rollers and spindle neck should be oiled carefully every day. In order that the oiling may have its proper effect both necks and rollers must be kept free from waste. When rollers are not properly oiled they require too much pressure from the brass roller to drive them. This has a tendency to chafe the "soft rove," and if the roller is the least broken it will more readily do it. In regard to the effect on the spindle of improper and irregular oiling, the spindle is not driven up to the proper speed, and consequently the thread, from want of twist, has not strength enough to make it spin. Now, it is not necessary for more than a few spindles and rollers to be in want of oil to cause the spinner and overseer a great amount of trouble by these few constantly breaking. Another fruitful source of annoyance is careless or imperfect band tying, and it is essential to see that it is properly done, as the proper working of the machine in a great measure depends upon it. The knot used is a bow, which, after being tied, grows tighter the more it is pulled.

Rollers.—The pressing rollers form one of the most important cares of an overseer. They are now generally made of boxwood, but were at one time made of gutta-percha, and thorn or other wood is sometimes used. The two retaining rollers, and one of the drawing rollers, in a spinning frame are brass. These rollers are fluted, otherwise they would not take a sufficient hold of the soft wet rove. These brass rollers are fluted, according to the lea of yarn to be spun, from 24 to 40 flutes per inch diameter, and the wooden pressing rollers are fluted to correspond, it being evident that unless the wooden one is fluted in every way similar to the brass one they will not run into one another as they should. The two brass retaining rollers have generally fewer flutes per inch than the drawing rollers. First, the flute should be perfectly round on the top and bottom, with no sharp lines, so that the top of the

flute of the wooden roller will just fit into the hollow of the brass, and *vice versa.* If the top of the flute of the wooden roller be sharp instead of round it will not fit the hollow, but will incline to cut the material. In order to examine them they should be held between the eye and the light, looking along the flute, when any imperfection will be seen. A good look-out should be kept for small flutes, which often occur, interfering with the proper running of the roller. Another defect of the flutes is their not being properly formed on the top and bottom, being too square, with an appearance of being cut, instead of rising with a gradual curve. These imperfections may not be distinguished while the rollers are in the frame, but should be examined in the way directed, and the defective ones sent back to the fluting department. Rollers may also vary in the diameter of their two bosses. This can only be detected if the difference is small by measuring. Rollers with high flutes and imperfect in form can be detected by their uneven motion. After the rollers have run a short time the flutes will commence to wear and break. The slightest imperfection may be detected, after a little practice, by holding the thumb against the roller while in motion. This should be done daily, the bad ones being replaced. If not taken out they will, if the material is strong, cause beaded, bagged, or snarled yarn, and they will also, by improper drawing, cause uneven yarn. No fault is worse in yarn, and especially in warps, than beading, yarn in this state being quite useless. The most frequent cause is bad rollers; but, besides this, allowing the water to get cold; or the water in the trough to get low, and running in cold water too fast, produces the same result. The reach being too short is also another cause. In nearly all wet spinning mills the water used for condensing is afterwards used for this purpose, but even this requires to be run in slowly. It is desirable to keep the rollers in the frames as long as possible, and in order to do this, having the pressing roller right, the brass roller must be kept in good order,

and fluted every three, four, or five years. The pressure is got by a lever and weight which pull the saddle containing the two pressing rollers, and this weight should just be a little more than sufficient to draw the material required. Notches are provided on the end of the lever for this purpose.

Rule to find Pressure on Roller.—Multiply weight on end of lever by distance in inches between lever and fulcrum, and divide by distance between fulcrum and spring rod which bears on the saddle.

Example.—Weight 14 lbs., distance between weight and fulcrum 12 in., distance between fulcrum and spring rod $1\frac{1}{4}$ in.

$$\frac{14 \times 12}{1\frac{1}{4}} = 134\tfrac{1}{2} \text{ lbs.}$$

Supposing you require to put the same weight, $134\frac{1}{2}$ lbs. on a frame with 1 in. fulcrum and 12 lb. weights; then $\frac{134\frac{1}{2} \times 1}{12} = 11{\cdot}2$ in., required length of lever. Short rove traverse and narrow bosses require less weight. Boxwood rollers are very apt to crack during dry or hot weather, especially between Saturday and Monday, and watering with a can is usually adopted to prevent this; but in the middle of summer and during protracted holidays it will be found advantageous to place along the top of the rollers a layer of wet waste. They will then require less watering, and fewer cracked ones will be discovered. Rollers would soon get worn if the rove were allowed to run in one groove, and consequently a traverse motion is applied, which carries the rove slowly from one side of the roller to the other; of course the greater the length of the traverse the less likely is the roller to become bad. This, however, may be overdone, and it will be more especially noticed when the stands get worn. If not repaired, the roller moves too much to one side, and so allows the rove to get out. Another, and not so easily noticed, result of a too long traverse is that the thread makes too large an angle with the thread plate. This puts too great a strain on

weak or fine yarns, so you must regulate the distance the guide travels on each side of the centre according to the yarn you have to deal with.

Builders.—On builders being right and working right (taking for granted that the spindles are in line) depends the manner in which the bobbin is filled. The part on which the bobbins run should be planed and in line. The rods which support the builder, raising it up and down, are supplied with nuts and screws, so that you can regulate the building of the yarn on the bobbins at the top or bottom as you please. It is essential to have not only the traverse of the bobbins exactly the same, but also the bottom or drag end, and if there are differences in the thickness of these it is impossible to have the builders set right. This most frequently occurs by receiving bobbins from different makers. Reelers, however, will keep spinning overseers well informed as to the state of their frames in this respect. An overseer once said to the writer: "A side of this frame" (pointing one out which was spinning 50's weft) "has something wrong with it which I cannot discover. The spinner has no trouble with the opposite frame, neither has the spinner on the other side of the same frame any trouble." After examining the frame carefully we could see nothing which would be likely to cause any defective working. For two or three days this side continued a curiosity. We discovered accidentally the very simple cause of this annoyance to the spinner and overseer. It was this: At the back of the builder there are placed slots to hold the drag band, and generally cast with the builder. This one happened to be a strip of brass screwed on the builder with the slots for the drag band. The brass had been lowered from its original position, so that the band was on an incline from the back to the front. This caused the bobbins to be bearing too heavily on the back and not at all on the front, the bottom of the bobbin pressing against the back of the spindle, and the front pressing against the top of the spindle, thus causing a

shake, and making the bobbin stiff to take round. On looking along the bottom of the bobbins from the end of the frame it was seen that the bobbins were only running on the back side, but with so little distance between the front of the bobbin and the builder that it required close observation to see it. The brass having been raised to the proper place the bad spinning was effectually cured. The back slot should be in line with the front, and when the band is possed along the groove in the bobbin it should just allow the bobbin to bear on the builder and nothing more

Flyers.—In flyers for wet spinning the brass eye upon which the thread bears most should be made a little larger than the thickness of the yarn. If the eyes are too large they are liable to bend and get out of the proper length. In course of time the eye gets cut with the thread, and if it is allowed to run afterwards the thread gets broken in coming to a weak point or to a lump. Flyers thus worn are repaired by removing the old eye and inserting new wire, the eye being turned on a block to the length required. The eye should not be in line with the flyer leg, but should be so bent that the thread passes up the side of the flyer. After a time the flyer gets cut on the "shoulder" and "leg," and this has the same effect on the yarn as cut eyes. On a frame which had the flyers badly cut it was noticed that better spinning could be made of a certain number in weft yarns than could be made of warps from five to eight leas heavier. The cut in the flyers allowed the fine thread to go through, while, on coming to a lump, the heavier and stronger yarn was broken.

Although it is more trouble to have flyers with one eye than with two, it is better, for various reasons. In one-eyed flyers one leg is made to balance the leg which has the eye, and if this eye gets cut, broken, or knocked out, it must be replaced: whereas with the two-eyed flyer, if one is out, the centrifugal force causes

a greater drag with the flyer running at, say, 4000 revolutions per minute. There is also less risk of the spinner keeping cut flyers if there is only one eye in the flyer; but if there are two, on stopping the flyer and finding the nearest eye cut, she may turn to the other, assuming it to be right, without examination.

Water.—The temperature of the water in the troughs requires attention. The heat required depends on the strength and nature of the material under process. Hot water has the effect of softening and putting the fibres together, thus enabling small quantities to be drawn easily. For weak and soft material water moderately hot will do, whereas with strong material the water will require to be at or near the boiling point.

Water Troughs.—As there is always more or less sediment the troughs require thorough cleaning from time to time. The steam should pass through a valve before coming into the mill, to reduce the pressure to, say, 3 or 4 lbs. If the steam is turned on at a high pressure it raises this sediment, which may adhere to the rove and form lumps on the yarn. In the same way, the rods and the part of the trough where the rove enters should be regularly cleaned.

Temperature of Rooms.—On this question great differences of opinion exist, and not without reason; for while in one room you have strong, heavy numbers which may not be particularly affected by the temperature, in another you may have finer yarns, which are very susceptible to cold. Draughts are always to be avoided. Formerly a system was adopted in mills of having ventilators, one opposite each frame, close to the floor. In summer or warm weather the evil effect was not so apparent, but in cold weather, especially with frosty air or strong winds, the effects were most

injurious. The cold acting on the sliver just out of the warm water sharply contracted it, with the result of weak or fine yarn breaking. The same objection holds good, though not so strongly, with regard to ventilators close to the ceiling. In my opinion, nothing surpasses the window for ventilating a spinning room. You can open the window on the leeward side of the room and modify the effects of the cold much more easily than with ventilators, which are very liable to get rusted. In fine numbers wind dries the rollers, causing a tendency to lap up.

Relative Position of Brass Roller, Thread Plate, and Spindle.—Any person will observe that the thread does not pass perpendicularly from the roller to the spindle. If this were the case, when the tension or drag becomes too slight and the thread slackens a little, it would be liable to get entangled in the flyer. The front of the roller from which the thread is delivered is placed a certain distance back, and so the thread comes in a slanting direction to the spindle; but the thread (if there were no thread plates), having to move round the spindle at a certain distance, would, when furthest from the roller, bear very hard on the bobbin, and when nearest would not bear at all, which would evidently not do; consequently, thread plates are used, being placed above the spindles, with a small hole directly perpendicular to and above the spindle, so that the thread runs at an angle to the thread plate, and thence to the flyer. The thread plate must be placed as far above the spindle as will allow the thread to pass to the eye of the flyer without rubbing on the head of the bobbin. The distance of the face of the brass roller from the line of the spindle depends to a certain extent on the height of the roller above the thread plate. The nearer the roller is to the thread plate the less distance is it from the line of the spindle; and this height of the roller above the spindle and distance back from the line of the spindle depends on the pitch of the spindles. Thus, in 3 in. pitch frames the height of the roller above the

spindle varies from $7\frac{1}{2}$ in. to 9 in. and 1 in. back from the line of spindle; and in $2\frac{1}{4}$ in. pitch, height above spindle 7 in. to $7\frac{1}{2}$ in. and $\frac{5}{8}$ in. back from the line of spindle. As it is necessary to have the yarn delivered off the brass roller, the centre of the pressing or wooden roller must be placed a little above that of the brass roller. Drawing a line at right angles to the beam which carries the stands (this beam is parallel to a line drawn from the front of the top roller to the front of the bottom roller) through the centre of the bottom brass roller, will give you a line on which, if you place the centre of a pressing roller the same size as the brass roller, the thread will not deliver off either; and placing the line a little above this gives the proper position of the pressing roller, the distance above the centre varying with the pitch of frames. Placing the roller line too low will allow the thread to deliver off the wooden roller, if large, or placing it too high will, as already explained, cause the flutes of the wooden roller to wear out sooner, owing to the position in which it is driven by the brass roller. The top brass roller has now to be placed in a position so that the rove will enter between the two drawing rollers, bearing rather on the brass than on the pressing roller before entering the "nip." The pressing roller being too high above the centre will also cause it to bear on the rove, unless the top roller is put unnecessarily far back. The position of the pressing roller varies with its size, and this is partially counteracted by the ewe or slot in which the saddle moves; but in fine numbers the position of the top pressing roller is altered in accordance with the different sizes of the bottom pressing rollers. As the drawing roller brasses wear much sooner than the top, the top roller is set a little further back than is actually necessary to counteract this, but not enough to allow much wear on the brasses. Taking also into account the too heavy friction on the thread plate if the drawing roller brasses are much worn, the great necessity will be seen of keeping them in good order and the drawing roller in its proper position. If the yarns are weak it will

be impossible to spin the same lea, or, at least, to have the same production.

Pitch of Frames.	Bottom of the Spindle Screw to Nip	Distance back from the line of Spindle.	Distance of Pressing Roller above the centre
3 ins.	$7\frac{3}{4}$ ins.	1 in.	$\frac{3}{16}$ in.
$2\frac{3}{4}$ "	$7\frac{1}{4}$ "	$\frac{7}{8}$ "	$\frac{5}{32}$ "
$2\frac{1}{2}$ "	$6\frac{3}{4}$ "	$\frac{7}{8}$ "	$\frac{1}{8}$ "
$2\frac{1}{4}$ "	$6\frac{1}{4}$ "	$\frac{13}{16}$ "	$\frac{3}{32}$ "

Temper or Drag Weights.—The manner in which the drag band should be placed along the bobbins has already been explained. The weight applied to the drag band is a simple matter. It should be such that by increasing your drag or friction by slow degrees you should have almost, but not altogether, exhausted the dragging power by the time the bobbin is full. If when the bobbin is full you have exhausted the drag on some, then your weight is too light, because occasional bobbins which are easier driven, from various causes, require more drag, and through not having any more to put on the thread "snarls," &c. Again, if you require only to move the drag one-fourth or one-half of the distance available, then your drag is too heavy, and the heavier, of course, the less movement, while if it is sufficiently heavy, the thread strong enough, and the bobbin light, there could be put on at first as much as would do throughout, but this rarely occurs. However, the proper weight for any frame may be easily determined.

Speed of the Bobbin.—A puzzling question with regard to the speed of the bobbin is whether the bobbin on the spinning frame goes faster when empty or when it is full. The correct answer is, quicker when full; but, on first looking to the increase of drag, one is apt to assume that the contrary is the case. The increase

in drag is to counteract the greater power which the flyer attains in pulling round the bobbin as its diameter increases. The way to explain it is this: Supposing your roller is delivering 400 inches per minute, and the bobbin at the start is $1\frac{1}{2}$ in. circumference, and the speed of spindles 4000 revolutions per minute, it will be seen that the spindle would require, having a delivery of 400 inches to put on the bobbin, just 400 revolutions if the bobbin were 1 in. circumference, but as the bobbin is $1\frac{1}{2}$ in. it will require 266 revolutions. If the bobbin were to go as quick as the spindle none would be put on; but supposing it went 266 revolutions slower than the spindle, then the 400 inches would be put on; that allows the bobbin 266 revolutions less than 4000, which equals 3734 revolutions of the bobbin when its circumference is $1\frac{1}{2}$ in. When the bobbin increases to 3 in. circumference, having still 400 in. delivery per minute to put on, $\frac{400}{3} = 133$ revolutions of spindles now required, as the bobbin has increased in size, and one revolution of the spindle now puts on 3 in., which at the start only put on $1\frac{1}{2}$ in. Then 133 revolutions putting on the delivery of 400 in., your bobbin has only to go 133 revolutions slower than the spindle, then $4000 - 133 = 3867$ revolutions when the bobbin is full and 3 in. circumference, against 3734 revolutions when empty and $1\frac{1}{2}$ in. circumference. This is exactly the same as in the case of the roving. In the roving the bobbin has a separate motion; in the spinning the bobbin receives its motion from the spindle, and the diminished speed is obtained by the drag.

Before leaving the spinning department we may add one or two suggestions. The rollers should be carefully watered before starting in the morning; and on a Monday, particularly, not only the rollers, but also the rove between the rollers, which will have dried during the interval, should be watered, otherwise it will not draw well, thus making a bad start. The next thing is the starting of frames. How many spinners know the way

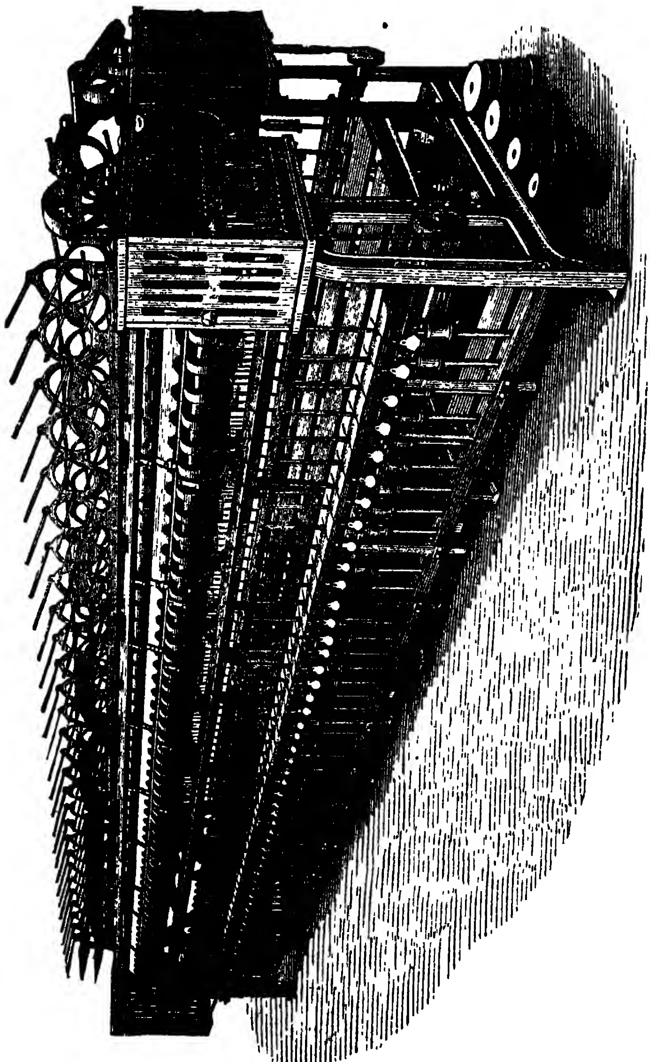
to start a frame? This is as essential for the doffing mistress to know. Instead of moving the belt on to the tight pulley a little, stopping it there, then on a little further, then back, and so on, giving an irregular motion, the belt should be put on slowly, but without stopping. In putting it on, you will require to hold the belt guide handle with both hands, the one pushing on, and the other preventing it coming back or going on with a jerk.

DRY SPINNING.

MACHINERY was first applied to spinning without the aid of water. The dry spinning frame, not having hot water and the other appliances which water necessitates, is comparatively simple, and yet it gives scope for a great amount of study. Although its appearance may give the idea that its construction and working are matters of perfect simplicity, a close acquaintance removes this impression The care that is necessary to success is not always exercised in making dry spun yarns. Much of this carelessness may be attributed to the poorer material that is used, in the working of which a few lumps in heavy tow sizes are deemed of little consequence. He who can turn the best yarn out of a given material is the person who succeeds as a spinner; for even supposing the better quality of the yarn is not taken into account, the production is greater and the waste less, hence firms who conduct their works in a careful manner are able to have larger profits, or, if necessary, to undersell their opponents, supposing always that the well and ill worked concerns stand on the same footing with regard to machinery. Old machinery, or machinery in need of repair, is out of the running nowadays. The secrets of the decline of our "Scotch country mills" are their antiquated machinery and mode of working.

In dry spinning frames, as with any of the other machinery, the overseer requires first to be able to take the ordinary calculations, the most important here being draft and twist. The draft on a dry spinning frame is taken in precisely the same manner as on a wet spinning frame. The explanation of the following rule will be found in the pages devoted to wet spinning.

Rule to find the Draft.—Multiply the stud wheel by the top roller wheel multiplied by the diameter of the



Dry-Spinning Frame.

drawing roller, and divided by the drawing roller wheel multiplied by the change pinion multiplied by the diameter of the retaining roller. To find the standing number leave out the change pinion, or if the drawing roller pinion is used as the change pinion leave it out of the calculation.

In dry spun yarn the size is almost entirely denoted by the weight per spindle, which contains 48 cuts, hence we have a different rule for finding the draft for the spinning frame from the weight of the rove from that which is given in wet spinning, where the size of yarn is denoted by the leas or cuts per lb. For instance, yarn termed 3 lbs. is 1 spindle or 48 cuts weighing 3 lbs., 4 lbs. is 48 cuts weighing 4 lbs., and so on. Now, if 48 cuts equals 4 lbs., then we have $\frac{48}{4} = 12$ cuts or leas per lb., so that 4 lbs. yarn equals 12 lea yarn. We thus can find the lea that dry spun yarn is by dividing the lbs. per spindle into 48, and by dividing the leas per lb. of wet spun yarn into 48 we have the number of lbs. weight per spindle it equals.

Having these different methods of denoting the size of yarn in wet and dry spinning, we must also have different rules for finding the draft for a spinning frame from the weight of rove per 100 yards, or from the number of yards per ounce. The rule when we want leas per lb. we have already given in "Wet Spinning."

Rule to find Draft, having the number of yards of rove per oz.—Multiply the yards per oz. by 16 and by the required weight of yarn per spindle, and divide the result into the number of yards in a spindle—14,400.

Example.—Number of yards of rove per oz. 25, required the draft for yarn 6 lbs. per spindle.

$$\frac{14{,}400}{25 \times 16 \times 6} = 6 \text{ draft.}$$

The reason of this rule is:—Having rove weighing 1 oz. per 25 yards, and requiring draft for 6 lbs. per spindle, we have 16 oz., or 1 lb., of rove, measuring $25 \times 16 = 400$ yards, then 6 lbs. of rove will measure $400 \times 6 = 2400$ yards. As we require the yarn to be 6 lbs. per

spindle, or 6 lbs. measuring 14,400 yards, we ascertain by division the number of times 2400 yards are contained in 14,400.

$$\frac{14{,}400}{2400} = 6 \text{ draft, without allowance for contraction.}$$

As mentioned in "Wet Spinning," the yarn is increased in weight by contraction by twist, and consequently the draft obtained by the foregoing rule will require to be made longer, the amount added depending on the amount of twist the yarn receives. A short rule, similar to that given in "Wet Spinning," giving a draft with the addition of 7 per cent., is the following:—

Rule to find the Draft to be put on the spinning frame, the weight of rove per 100 yards and the required lbs. per spindle being given.—Multiply the weight of 100 yards in drs. by ·6, and divide by the lbs. per spindle required.

Example.—If 100 yards weigh 40 drs., and yarn weighing 3 lbs. per spindle is required.

$$\frac{40 \times \cdot 6}{3} = 8 \text{ draft.}$$

The reason of this rule is as follows:—If 100 yards weigh 40 drs., then 300 yards or 1 cut weighs $40 \times 3 = 120$ drs., and 1 spindle or 48 cuts of rove $= 120 \times 48 = 5760$ drs. But as we want yarn weighing 3 lbs. per spindle, or 256 drs. $\times 3 = 768$ drs., by dividing 5760 by 768 we get the draft 7·5 without any allowance for twist. Placing the above calculation in this form, $\frac{40 \times 3 \times 48}{3 \times 256}$ we find that the first term in the dividend is the weight in drs. of 100 yards rove, and the first term in the divisor is the weight in lbs. the yarn may be wanted per spindle, and these two are always varying, but the next two in the dividend and the remaining one in the divisor are always the same, no matter what the rove weighs or what weight the yarn is wanted, so we simplify the fraction $\frac{3 \times 48}{256} = \frac{\cdot 56}{0}$ and this gives us $\frac{40 \times \cdot 56}{3} = 7 \cdot 5$ draft, the same as before; but, as about 7 per cent. is required to be added to the draft to counteract

the increased weight of the yarn by contraction by twist, we add 7 per cent. to ·56, which = ·6, making the draft longer, and this gives us, instead of the simplified formula $\frac{40 \times \cdot 56}{3}$ without allowance for contraction by twist; $\frac{40 \times \cdot 6}{3}$ with allowance for twist. This gives us the rule as before, multiply drs. in 100 yards by ·6 and divide by lbs. per spindle. Of course it depends on the size of the yarn and the amount of twist given whether 7 per cent. is too much or too little; however, a very short experience will show whether more or less than 7 per cent. would need to be allowed for.

Rule to find Weight of Rove per 100 *yards, the draft and weight of yarn being given.*—Multiply draft required by lbs. per spindle and divide by ·6.

Example.—Draft being 8 and weight of yarn 3 lbs. per spindle. $\frac{8 \times 3}{\cdot 6} = 40$ drs. per 100 yards.

If a new size is being brought forward, the draft pinions required, instead of being obtained by dividing the draft required into the standing number, are sometimes found by proportion—a longer and not so correct a way, especially if you have a different weight of rove and require a different size of yarn from that spinning.

Twist.

The manner in which to find the amount of twist on a dry spinning frame is exactly the same as already given in "Wet Spinning."

Rule.—Multiply the stud wheel by the drawing roller wheel multiplied by the diameter of the cylinder, and divide by the cylinder pinion multiplied by the diameter of the warve multiplied by the change pinion multiplied by the circumference of drawing roller. In order to find the standing number leave out the change pinion. Refer to "Wet Spinning" for a full explanation.

In dry spinning the proportionate twist of one number

to another is determined by the square root of the weight in lbs. per spindle. Thus, if we have 6·5 twists per inch for 4 lbs., what twist will we require at the same rate for 5 lbs.? $\sqrt{5} : \sqrt{4} :: 6·5 : 5·81$ twist per inch. The proportionate twist for the various sizes is very often taken from the twist which would be given to 3 lbs. Thus, in denoting the twist on any size it is said to have a certain number of twists per inch, or to be at a rate corresponding to a certain number of twists for 3 lbs. Thus having the twist which would be given to 3 lbs. as data, we can find the corresponding twist for any other size.

Rule.—Square the required rate, multiply by 3, divide by the lbs. weight per spindle of the yarn required, and extract the square root.

Example.—What twist is required for yarn 4 lbs. per spindle, at the rate of 8 twists for 3 lbs. Here we have the twists required at the rate of 8 for 3 lbs., hence $8^2 = 64$, and multiplied by $3 = 192$, then dividing by 4, the number of lbs required, $\frac{192}{4} = 48$, and the square root of this number $48 = 6·9$, the required twist for 4 lbs. to be at the rate of 8 for 3 lbs.

In the foregoing rule the first two things required may be formed into a table as given below, that is the square of the different twist rates multiplied by 3, so that we may have simply to divide the lbs. per spindle wanted into the standing numbers thus found and extract the square root.

Rates for 3 lbs.	Squared and multiplied by 3	Standing No.	Rates for 3 lbs.	Squared and multiplied by 3	Standing No.
6	$6^2 \times 3$	108	8·25	$8·25^2 \times 3$	204·18
6·25	$6·25^2 \times 3$	117·18	8·5	$8·5^2 \times 3$	216·75
6·5	$6·5^2 \times 3$	126·75	8·75	$8·75^2 \times 3$	229·68
7	$7^2 \times 3$	147	9	$9^2 \times 3$	243
7·25	$7·25^2 \times 3$	157·68	9·25	$9·25^2 \times 3$	256·68
7·5	$7·5^2 \times 3$	168·75	9·5	$9·5^2 \times 3$	270·75
7·75	$7·75^2 \times 3$	180·18	9·75	$9·75^2 \times 3$	285·18
8	$8^2 \times 3$	192	10	$10^2 \times 3$	300

In a similar way, if we have a given twist for any other size than 3 lbs., we can find the required twist for other sizes. Thus, if we have 6·5 twists per inch for 4 lbs., what twist will we require at the same rate for 5 lbs.?

$$\frac{6{\cdot}5 \times 6{\cdot}5 \times 4}{5} = 33{\cdot}8; \text{ and } \sqrt{33{\cdot}8} = 5{\cdot}81$$

Another method, which is not so simple, is to bring the lbs. per spindle to leas per lb., and proceed as in wet spinning, multiplying the square root of the leas by the data. Thus, to find the twist for 6 lbs. at the rate of 8 twists for 3 lbs.: As 3 lbs. per spindle = 16 lea, we have also 8 twist for 16 lea. The square root of 16 = 4, and this number divided into the twist gives what the square root of the lea is multiplied by, $\frac{8}{4} = 2$, or twice the square root of the leas is at the rate of 8 for 3 lbs. Finding now that 6 lbs. = $\frac{48}{6} = 8$ lea, we multiply the square root of this number by 2—thus, $\sqrt{8} = 2{\cdot}825 \times 2 = 5{\cdot}65$ twists, as may be obtained by ordinary rule for dry spinning. We have given a twist table in a subsequent part of this book, and on reference to it the dry spinner will see at a glance what twist per inch he will require for any given size, the rate for 3 lbs. being known.

In dry spinning a great many of the details are exactly the same, and reference may be made to "Wet Spinning" for speed of spindles, regulating builders, oiling, band tying, starting frames, weight on levers, position of drag bands, builders, &c.

The rule for finding the speed of the spindles is exactly the same as in wet spinning. The following is the rule for finding the speed of the drawing roller. It is really of very little practical use, and is very simple, being purely a matter of drivers and driven.

Rule.—Multiply the speed of the shaft by the diameter of the drum multiplied by the cylinder pinion multiplied by the twist pinion, and divided by the diameter of the pulleys multiplied by the twist stud wheel multiplied by the drawing roller wheel.

To find the turn-off per minute—multiply the result found by the above rule by the circumference of the drawing roller, and this result multiplied by the number of minutes worked per day, or any given time, less the time stopped for doffing, &c. At the same time it will be seen that the speed of the drawing roller varies with the twist wheel, unlike the spindles, which, if the pulleys be not altered, always keep the same speed, although the yarns may vary. In regard to builders they are made wider than in wet spinning, a greater distance being between the bobbin and the front and the back of the builder. This does not make such a stiff drag, having more length of drag-band from front to back of the builder. In wet spinning the position of the thread plate would not allow the builder to be taken off if it were as wide as in dry spinning generally. Unless in case of accident, builders in dry spinning never require taking off, whereas in wet spinning they must be taken off, say, once a week for cleaning.

Rollers.—Unlike the wet spinning frame, we have here the pressing roller at the back of the iron roller. The rollers are plain instead of fluted, and sycamore or plane-tree wood is used instead of boxwood. Looking at wet and dry spinning frames the reasons for these differences are obvious. The rollers require no fluting, as they have a dry fibre to draw, and with an ordinary weight have little tendency to slip. However, for very heavy dry spinning the rollers are what is technically termed "scratched." Plane-tree is used universally in dry spinning. It must be thoroughly seasoned, something after the fashion of alder wood, for preparing rollers, and it requires at least two or three years for this purpose. Rollers should be turned as narrow at the circumference as the size of yarn required will allow, for with a too broad face the middle becomes hollowed, the roller drawing some of the fibres misses others, thus causing beading. They should also be turned with a slightly round face tapering off to

the edges, very little, but sufficient to counteract hollowing. Overseers require to be very particular in keeping their rollers in good trim, and in having them systematically examined every day. When rollers get damaged they are generally turned up with a chisel, or scraped, so to speak, by holding the chisel square to the lathe, and when a proper surface is obtained they are measured with calipers, so that both rollers may be of the same diameter. A still better way is to slide the rollers in a lathe, then do the slight rounding off the face, narrowing, if required, as the roller comes nearer the centre, and tapered from circumference to axle, according to the way in which they are first made. Another plan of renewing the surface is adopted in some places, namely, by fixing the roller firmly and filing. As it is impossible to file a roller true, and to take out broken parts without leaving hollows, &c., it is disapproved by most practical people, and on the ground of economy alone is not worth consideration. In order to prevent dents across the face of the roller, caused by lumps going in, raising the lever and coming down suddenly, and also to take a great weight off the floor, various modes of applying pressure to the rollers have been adopted. A good deal must depend on the nature and size of yarn being worked. Spring rods, with indiarubber washers, &c., are introduced into some, while others have a steel spring. Great care must be exercised where they are used, not to put on more pressure than is required, for this is highly detrimental. During holidays the pressure should be taken off the rollers, otherwise they will be dented by the constant pressure of the iron roller in one place.

Flyers, &c.—The flyer in dry spinning, although doing the same work, and placed on the spindle in the same way as in wet, differs in construction, the manner in which it transfers the thread from the roller to the bobbin, &c. Instead of a brass eye, the leg of the flyer is slightly flattened, and an eye cut out of the centre, through which the thread passes.

The steel eye or palm of the flyer will stand a considerable time without cutting, whereas with wet yarn it would stand a very short time. As much care, however, must be taken to have cut flyers renewed, by turning the palm or welding on new ones, as in guarding against cut eyes in wet spinning. The thread, instead of passing from the thread plate along the shoulder of the flyer to the eye and thence to the bobbin, passes between the spindle and one leg to the leg opposite, passing round it once and sometimes twice, and going from the inside of the leg to the outside of the palm and thence to the bobbin. This allows of a lighter drag being used, as the thread above the flyer has less tension than in wet spinning, because the thread being twined round the leg is not so liable to fly out and get broken. For the same reason the back of the drawing roller and the eye of the thread plate are almost in a direct line. so that the thread plate here merely serves to steady the thread. Lifting the thread plate away would not injure the work so much as in wet spinning, where the threads would break at once, as they would not move in a circle round the spindle as in dry spinning. Consequently, as already mentioned, the back of the drawing roller is placed almost in a perpendicular line with the spindles, and not, as in wet spinning, the front, which is the delivering side, the same as the back in dry spinning, placed back a considerable distance. This winding round the leg of the flyer causes most of the strain to be on the part of the thread between the eye and the bobbin, and little upon the thread which has not received its proper amount of twist. This is one of the reasons why poor yarns in heavy numbers can be spun easier dry than wet from the same material and with less twist.

Binding on Flax Frames.—Binding is to dry spinning what reach is to wet spinning. In dry spinning frames the reaches are never altered, because the fibres draw or should draw their whole length. For tow 7 to 7½

inches reach is the almost universal length, and for flax 18 inches; but still, as we have variation in size of yarn and strength to work over dry spinning frames as in wet, we must have something to counteract this. For this purpose binding is introduced. In line and tow frames we have next the roller a movable rod on which is supported small tin conductors tapering to the mouth, which conduct the rove between the drawing rollers as near the point where the rollers take hold of the fibres as possible. Above this we have a plate along which the rove passes, and above this plate we have in line frames two rods. These rods extend from one end of the frame to the other, as do also the plates; they are movable backward and forward like the tin or conductor rod. The plate, which is sometimes called the breast-plate or conductor plate, is also movable backward or forward, and can be set with any slope. The top may be screwed in and the bottom out, or *vice versa*, without moving the plate out or in. Let us first take flax spinning, and in it we have the rove passing over the front of the first rod behind the second rod, and thence down the face of the breast-plate and conductors to the rollers. Now, there is a certain place that binding requires to be put on more or less on every rove. Let us take a common size, 3 lbs., and, commencing with a very strong warp, we will require a rove slack twisted. In all flax roves, unless they are exceptionally poor and short, the rove should be twisted just a shade harder than is sufficient to come off the rove, a shade harder perhaps than in wet spinning, but under no circumstance should it be hard twisted, as it is an utter impossibility to make a level yarn from a hard twisted rove. Then, supposing you are spinning a 3 lbs. warp, your flax will be strong, and light binding will necessarily require to be applied. The breast-plate, which is next the conductor rod, and along which the rove passes, must be in such a position that the rove will bear lightly on it, and on the lowest part bear scarcely at all. The conductor rod is set so that the twist comes freely out without allowing the rove too much freedom

to open. The binding rod next the breast-plate has now to be set, and if the flax is very strong it will only require to be set a very little back behind the breast-plate. The top rod has now to be brought out, and you must judge how far by the tension which you feel between the breast-plate and lower binding rod, and between the lower part of the breast-plate and the conductor rod. Too much or too little binding has the same effect upon the yarn in making smalls as a too short or too long reach has in wet spinning, and consequently, on examination of the yarn, if too little binding is given the smalls will be long, and if too much short. In the case of strong material the tension should feel easy, but not slack, above the tin rod. Taking a very poor 3 lbs. flax yarn, the binding must be increased, and as generally a good proportion of Rjeff and Baltic flax is used with little strength or length of fibre, but with the effect of making a soft clean yarn. the breast-plate should be brought out, making the rove bear pretty firmly on it, and the conductor rod brought out and placed in a position in regard to the breast-plate a shade farther back, on account of the twist, through better binding being held better in. Having brought the breast-plate out gives you already more binding on the low rod, but it can be put back so as to increase the binding and allow little action above this rod, and in that case the top rod may be placed so that the rove bears very little on it. If you did not put a considerable amount of binding on rove such as this the effect would be, with a slack twisted rove, to carry short fibres, nap, &c., into the yarn before actually being drawn by the rollers, thus making very bad "faults" in the yarn. This action is characterized by overseers as going away in slubs, which, of course, leave small parts in the thread behind them. Again, for very poor line yarn, leaving the tin rod and lower part of breast-plate in the same position, and bringing the top out and putting the low rod well back, makes still tighter binding.

Binding on Tow Frames.—In dry spinning the greater

portion of yarn made is from tow, and the low quality compared with that used in wet spinning, except in special cases, makes it an important duty to keep the yarn as even as possible. The plates, as in the flax frame, are movable, extending near to the top roller, and do not require any binding rods. For tow a single binding rod also is used, without the breast-plate, but generally for heavy sizes, and this rod is not only movable out and in, but it can be raised or lowered from the conductor rod. If the material be weak the rod is kept near the conductor rod, and higher if it be strong, and it is regulated on this principle as the case may require. In some very low qualities of tow a little extra twist must be put on to prevent slubbing, and a pretty fair bearing must also be kept on the tin conductor. With the rod you cannot, having a light rove, obtain very much binding, as the rove would not carry.

Conductors.—A great variety of conductors are used, and one must judge from the material used and size of thread which is most suitable, care being taken to have them reaching as near the nip as possible without bearing on the iron roller, and to allow the rove to open a little, collecting and leading the fibres to the nip without allowing them to spread over the side. Care must also be taken to remove worn ones, for although provision is made, in a hollow, for the iron roller to clear them, still at the points they get worn, and might check the fibre, thus producing rough yarn.

Draft.—The amount of draft depends on the material and size of the yarn, as in the case of wet spinning, but we can have a longer draft, as it will be seen that the material is in a very different state when being drawn wet from what it is when dry. For 3 lbs. flax warp, 8 of a draft makes a very good yarn, increasing to 9 for, say, 2 lbs.; in tow, for 3 to 3½ lbs. warp, 7½ to 7. For weft, generally speaking, the drafts are used longer, and 6 lbs. canvas tow is mostly spun with a 7½ to 8 draft. The yarn is rough, and more

importance is attached to cheap production than level yarn, which would be obtained with a draft of about 6. Long draft is advocated by some overseers, but some peculiarity in regard to their frames is usually found to explain this. For example, in spinning a poor 4 lbs. weft on a frame 8 in. reach with a binding rod placed close enough to the tin rod for 3 lbs., the consequence is that, with a light rove, little binding could be put on, as the rove has to make too sharp a turn round the rod into the conductor rod, with too great a distance between the binding rod and the retaining rollers.

SPINNING TWIST.

HAVING shown how to get the twist pinion, provided we have the twist or turns per inch required and the standing number, let us now look at the manner in which the twists for the different numbers are ascertained. The amount of twist is in proportion to the square root of the lea. Thus, the square root of 25 is 5, because 5 is the root or number which multiplied by itself equals 25, hence the square root of any number multiplied by itself equals that number. The most general twist is twice the square root of the lea for flax. Thus, for 25 lea you have 5, the square root, and 5 multiplied by 2 equals 10 twists. For tow the most general twist is the square root of lea multiplied by $2\frac{1}{4}$. These may only be taken as data from which to rise and fall, for the twist on yarn depends on a variety of things, such as the material used in making it, the purpose for which it is required, &c., so that in different places different twist tables are in use. The point to be aimed at generally in wet spun warps is that at which you have the greatest strength. Twisted above this point it becomes brittle, and below this it breaks without all the fibres being equally strained.

Wefts are generally twisted less than warps, because being needed to fill up the cloth they require greater softness. Warps require more strength, having to bear a greater strain in weaving. In some cases, but very rarely, and generally from unavoidable causes, wefts are twisted harder. Supposing you are making wefts with poor or weak material, you will require to twist it more, in order to make it spin and have sufficient strength. Again, in some fabrics it is necessary to have the wefts hard twisted. Manufacturers, however, know in what way they require their yarn twisted, and if

you have a new yarn to make and have a sample showing quality, twist, &c., you can judge by comparsion; or, if you know for what purpose it is intended, you can decide by practical experience what is required. In every mill there is a twist table, but a great many differ in the yarns they make, and the twist tables differ accordingly. If we take a place where the line wefts are strong though rough, they would be twisted by the square root being multiplied by 1·6 to 1·7, and good warps would be twisted to the amount of the square root multiplied by 1·8 to 1·9. In tow for the same class of yarn the square root would be multiplied by 2·1 for wefts and 2·2 for warps.

Again, in a place where the line wefts are very weak, the square root of the lea will be multiplied by 1·9 to 2, and the warps, which must always possess strength, and do not vary so much in different places, may be twisted the same as in the first case. In tow wefts, where they are very weak, the square root will be multiplied by 2·2 and the warps about the same. It will be seen in the last case that the wefts are twisted as much as the warps, otherwise they have not sufficient strength for spinning and weaving.

Generally speaking, wet spun wefts are made with as little twist as they will spin and weave with, and in dry spun wefts slack twist is even more essential, as the space to be filled up is generally greater, and as most linens made from dry spun yarns are mangled, calendered, or both, the softer the weft is the better it spreads, closing the cloth, and giving it a solid appearance. Flax warps, say 3 lbs. per spindle, do well with 7½ to 8, wefts the same size with 7 to 7½, and flax wefts, say 6 lbs. per spindle, at the rate for 3 lbs. of 6½ to 7½ twists per inch. Tow yarns, of course, require more twist, 3 to 4 lbs. warp at the rate of 7½ to 8½, and the same size of weft 7 to 8.

By the following table (No. 1) can be found at once the twist of any size of yarn compared with any other, showing also the weight of leas per spindle, their weight per English bundle, their square root, and twist

when the square root is multiplied by different data. Thus, if you are twisting 100 leas with 20 turns per inch, and wish to know what 25 leas would require at the same rate, you have first to find what the root of the lea is multiplied by to give 20 turns per inch The square root of 100 lea = 10, and by dividing 20 twists by 10, the square root, $\frac{20}{10} = 2$, you have what the square root of the lea is multiplied by. Now, the square root of 25 lea is 5, and this multiplied by 2 will give you the same proportion as 100 lea; thus, $5 \times 2 = 10$ twists for 25 lea. Having found by what the root of the lea should be multiplied, you can find the twist for any other in the same way; or, knowing by what the square root is multiplied, say by 2, see the column square root multiplied by 2 in the table, and opposite the required lea will be found the twist. In the same way this table answers for dry spun yarns. The first column shows the lbs. per spindle, and opposite the size which we require in the column under the required rate for 3 lbs. (the rates being shown at the head of the table) we have the actual turns per inch for that size. The table No. 2 is at rates not given in No. 1.

TWIST TABLE No. 1.

Lbs. per Spindle	Corresponding Leas.	Sq. Root of Leas.	Weight per English bundle.	At the rate of 3 lbs. of—											
				6	6 5	7	7·6	8	8·4	8·8	9	9·2	9 o	10	10·4
				Square Root of Lea multiplied by—											
				1·5	1·625	1·75	1·9	2	2·1	2·2	2·25	2·3	2·4	2·5	2·6
·16	300	17·320	·66	25·98	28·14	30·31	32·90	34·64	36·37	38 10	38·97	39·83	41·56	43·30	45·03
·174	275	16 583	·72	24·87	26·94	29·02	31 50	33·16	34 82	36 48	37·31	38·14	39·79	41·45	43·11
·192	250	15·811	·80	23·71	25·69	27·66	30·04	31 62	33 20	34·78	35·57	36·36	37·94	39·52	41·10
·213	225	15	·88	22·5	24·37	26·25	28·5	30	31·5	33	33 75	34·5	36	37·5	39
·24	200	14·142	1	21·21	22·98	24·74	26·86	28·28	29·69	31·11	31·81	32·52	33·94	35·35	36·76
·252	190	13 784	1·05	20·67	22·39	24·12	26·18	27·56	28·94	30·32	31·01	31·70	33·08	34·46	35·83
·266	180	13·416	1·11	20·12	21·80	23 47	25·49	26·83	28·17	29·51	30·18	30·85	32·19	33·54	34·88
·282	170	13·038	1·17	19·55	21·18	22·81	22 77	26·07	27·37	28·68	29·33	29·98	31·29	32·59	33·89
·3	160	12·649	1·25	18·96	20·55	22·13	24·03	25 29	26·56	27·82	28·46	29·09	30·35	31·62	32·88
·32	150	12·247	1·33	18·36	19·90	21·43	23·26	24·49	25·71	26 94	27·55	28·16	29 39	30 16	31·84
·342	140	11·832	1·42	17·74	19·22	20·70	22 32	23 66	24·84	26·03	26 62	27·21	28·39	29·58	30·76
·369	130	11 401	1·53	17·10	18·52	19 95	21·66	22·80	23 94	25 08	25·65	26·22	27·36	28·5	29·64
·4	120	10·954	1·66	16 43	17·80	19·16	20·81	21 90	23·003	24·09	24·64	25·19	26·28	27·38	28·48
·436	110	10·488	1·81	15·73	17·04	18·34	19 92	20·97	22·02	23·07	23·59	24·12	25·17	26 22	27·26
·48	100	10	2	15	16·25	17·5	19	20	21	22	22·5	23	24	25	26
·5	96	9·797	2·08	14·69	16·02	17·14	18·61	19 59	20·57	21·55	22·04	22·53	23·51	24·49	25·47
·505	95	9·746	2 10	14 61	15·83	17·05	18 51	19·49	20·46	21·44	21·92	22·41	23·39	24·36	25·33
·533	90	9·486	2·22	14·22	15·41	16·60	18 02	18 97	19·92	20·86	21·34	21·81	22·76	23·71	24·66
·564	85	9·219	2·35	13·82	14·97	16·13	17 51	18·42	19 35	20·28	20·73	21·20	22·12	23 03	23·96
·6	80	8 944	2·50	13·41	14 53	15 65	16·99	17·88	18 78	19 67	20·12	20·57	21·46	22·36	23·25
·64	75	8·660	2 66	12·99	14·07	15·15	16 45	17·32	18·18	19·05	19·48	19·91	20·78	21·65	22·51
·685	70	8·366	2·85	12·54	13·59	14 64	15 89	16·73	17·56	18·40	18·82	19·24	20·07	20·91	21·75
·738	65	8·062	3·07	12·09	13·10	14·10	15 31	16·12	16 93	17 73	18·13	18·54	19·34	20·15	20·96

·8	60	7·745	3·33	11·61	12·58	13·55	14·71	15·49	16·26	17·03	17·42	17·81	18·58	19·36	20·13
·872	55	7·416	3·63	11·12	12·05	12·97	14·09	14·83	15·57	16·31	16·68	17·05	17·79	18·54	19·28
·96	50	7·071	4	10·60	11·49	12·37	13·43	14·14	14·84	15·55	15·90	16·26	16·97	17·67	18·38
·1	48	6·928	4·16	10·39	11·35	12·12	13·16	13·85	14·54	15·24	15·58	15·93	16·62	17·32	18·01
1·066	45	6·708	4·44	10·06	10·90	11·73	12·74	13·41	14·08	14·75	15·09	15·42	16·09	16·77	17·41
1·2	40	6·324	5	9·48	10·27	11·06	12·01	12·64	13·28	13·91	14·22	14·54	15·17	15·81	16·44
1·25	38·4	6·196	5·49	9·29	10·06	10·84	11·77	12·39	13·01	13·63	13·94	14·25	14·87	15·49	16·10
1·37	35	5·916	5·71	8·87	9·61	10·35	11·24	11·83	12·42	13·01	13·31	13·60	14·19	14·79	15·38
1·5	32	5·656	6·25	8·48	9·19	9·89	10·74	11·31	11·87	12·44	12·72	13	13·57	14·14	14·70
1·6	30	5·477	6·66	8·21	8·90	9·58	10·40	10·95	11·50	12·04	12·32	12·59	13·14	13·69	14·24
1·71	28	5·291	7·14	7·93	8·65	9·25	10·05	10·58	11·11	11·64	11·90	12·16	12·69	13·22	13·75
1·75	27·4	5·234	7·29	7·85	8·50	9·15	9·94	10·46	10·99	11·51	11·77	12·03	12·56	13·08	13·60
1·92	25	5	8	7·5	8·12	8·75	9·5	10	10·5	11	11·25	11·5	12	12·5	13
2	24	4·898	8·33	7·34	7·95	8·57	9·30	9·79	10·28	10·77	11·02	11·26	11·75	12·24	12·73
2·18	22	4·690	9·09	7·03	7·62	8·20	8·91	9·38	9·84	10·31	10·55	10·78	11·25	11·72	12·19
2·25	21·3	4·615	9·38	6·92	7·49	8·07	8·76	9·23	9·69	10·15	10·38	10·61	11·07	11·53	11·99
2·4	20	4·472	10	6·70	7·26	8·02	8·49	8·94	9·39	9·83	10·06	10·28	10·73	11·18	11·62
2·5	19·2	4·382	10·41	6·57	7·12	7·66	8·32	8·76	9·20	9·64	9·85	10·07	10·57	10·95	11·39
2·66	18	4·242	11·11	6·36	6·89	7·42	8·05	8·48	8·90	9·33	9·54	9·75	10·18	10·60	11·01
2·75	17·4	4·171	12·06	6·25	6·77	7·29	7·92	8·34	8·75	9·17	9·38	9·59	10·01	10·42	10·84
3	16	4	12·5	6	6·50	7	7·6	8	8·4	8·8	9	9·2	9·6	10	10·40
3·2	15	3·872	13·33	5·80	6·29	6·77	7·35	7·74	8·13	8·51	8·71	8·9	9·28	9·68	10·06
3·25	14·7	3·834	13·53	5·75	6·23	6·70	7·28	7·66	8·05	8·43	8·62	8·81	9·20	9·58	9·96
3·42	14	3·741	14·28	5·61	6·07	6·54	7·10	7·48	7·85	8·23	8·41	8·60	8·97	9·35	9·72
3·5	13·7	3·701	14·59	5·55	6·01	6·47	7·03	7·40	7·77	8·14	8·32	8·5	8·88	9·25	9·62
3·75	12·8	3·577	15·62	5·36	5·81	6·25	6·79	7·15	7·51	7·86	8·04	8·22	8·58	8·94	9·30
4	12	3·464	16·66	5·19	5·62	6·06	6·58	6·92	7·27	7·62	7·79	7·96	8·31	8·66	9
4·25	11·29	3·364	17·80	5·04	5·46	5·88	6·39	6·72	7·06	7·40	7·56	7·73	8·07	8·41	8·74
4·5	10·66	3·264	19·13	4·89	5·36	5·71	6·20	6·52	6·85	7·18	7·34	7·50	7·83	8·16	8·48
4·75	10·10	3·178	19·80	4·76	5·26	5·56	6·03	6·35	6·67	6·99	7·15	7·30	7·62	7·94	8·26
4·8	10	3·162	20	4·74	5·13	5·53	6	6·32	6·64	6·95	7·11	7·27	7·58	7·90	8·22
5	9·6	3·098	22·22	4·64	5·03	5·42	5·88	6·19	6·50	6·81	6·97	7·12	7·43	7·74	8·05
5·5	8·22	2·952	24·34	4·42	4·79	5·16	5·60	5·90	6·19	6·49	6·64	6·78	7·08	7·38	7·67
6	8	2·828	25	4·24	4·59	4·94	5·37	5·65	5·93	6·22	6·36	6·5	6·78	7·06	7·35

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TWIST TABLE No. 1—*Continued.*

Lbs. per Spindle.	Corresponding Leas.	Sq. Root of Leas.	Weight per English bundle.	At the rate for 3 lbs. of— 6	6·5	7	7·6	8	8·4	8·8	9	9·2	9·6	10	10·4
				Square Root of Lea Multiplied by— 1·5	1·625	1·75	1·9	2	2·1	2·2	2·25	2·3	2·4	2·5	2·6
6·5	7·38	2·716	27·10	4·07	4·41	4·75	5·16	5·43	5·70	5·97	6·11	6·24	6·51	6·79	7·06
7	6·85	2·618	29·19	3·92	4·25	4·58	4·97	5·23	5·49	5·75	5·89	6·02	6·28	6·54	6·80
7·5	6·4	2·529	31·25	3·79	4·10	4·42	4·80	5·05	5·31	5·56	5·69	5·81	6·06	6·32	6·57
8	6	2·449	33·33	3·67	3·97	4·28	4·65	4·89	5·14	5·38	5·51	5·63	5·87	6·12	6·36
8·5	5·64	2·374	37·23	3·55	3·85	4·15	4·57	4·74	4·98	5·22	5·34	5·46	5·69	5·93	6·17
9	5·33	2·309	37·52	3·46	3·75	4·04	4·38	4·61	4·84	5·07	5·19	5·31	5·54	5·77	6·003
9·5	5·05	2·242	39·60	3·36	3·64	3·92	4·25	4·48	4·70	4·93	5·04	5·15	5·38	5·60	5·82
10	4·8	2·190	41·66	3·28	3·55	3·83	4·16	4·38	4·59	4·81	4·92	5·03	5·25	5·47	5·69
10·5	4·57	2·137	43·98	3·20	3·47	3·73	4·06	4·27	4·48	4·70	4·80	4·91	5·12	5·34	5·55
11	4·36	2·088	45·87	3·13	3·39	3·65	3·96	4·17	4·38	4·59	4·69	4·80	4·99	5·22	5·42
11·5	4·17	2·042	47·96	3·06	3·31	3·57	3·87	4·08	4·28	4·49	4·59	4·69	4·90	5·10	5·309
12	4	2	50	3	3·25	3·5	3·80	4	4·2	4·4	4·8	4·6	4·80	5	5·20
12·5	3·84	1·959	52·09	2·93	3·18	3·42	3·72	3·91	4·11	4·30	4·40	4·5	4·70	4·89	5·09
13	3·69	1·921	54·20	2·88	3·12	3·36	3·64	3·84	4·03	4·22	4·32	4·41	4·61	4·80	4·99
13·5	3·55	1·884	56·33	2·82	3·06	3·29	3·57	3·76	3·95	4·14	4·23	4·33	4·52	4·71	4·89
14	3·42	1·851	58·47	2·776	3	3·23	3·51	3·70	3·88	4·07	4·16	4·25	4·44	4·62	4·81
14·5	3·31	1·819	60·42	2·778	2·95	3·18	3·45	3·63	3·81	4·001	4·09	4·18	4·36	4·54	4·72
15	3·2	1·788	62·18	2·68	2·90	3·12	3·39	3·57	3·75	3·93	4·02	4·11	4·29	4·47	4·64
16	3	1·732	66·66	2·59	2·81	3·03	3·29	3·46	3·63	3·81	3·89	3·98	4·15	4·33	4·50
17	2·82	1·680	70·92	2·52	2·73	2·94	3·19	3·36	3·52	3·69	3·78	3·86	4·03	4·20	4·36
18	2·66	1·632	75·18	2·44	2·64	2·85	3·10	3·26	3·42	3·59	3·67	3·75	3·91	4·08	4·24
19	2·52	1·589	79·36	2·38	2·58	2·78	3·01	3·17	3·33	3·49	3·57	3·65	3·81	3·97	4·13
20	2·4	1·549	83·33	2·32	2·51	2·71	2·94	3·09	3·25	3·40	3·48	3·56	3·71	3·87	4·02
21	2·28	1·508	87·71	2·26	2·45	2·63	2·86	3·01	3·16	3·31	3·39	3·46	3·61	3·77	3·92
22	2·18	1·476	91·74	2·21	2·39	2·58	2·80	2·95	3·09	3·24	3·32	3·39	3·54	3·69	3·83
23	2·08	1·444	96·15	2·16	2·34	2·52	2·74	2·88	3·03	3·17	3·24	3·32	3·45	3·61	3·75
24	2	1·414	100	2·12	2·29	2·47	2·8	2·82	2·96	3·10	3·18	3·25	3·39	3·53	3·67
25	1·92	1·385	104·68	2·07	2·25	2·42	2·63	2·77	2·90	3·04	3·11	3·18	3·32	3·46	3·60

Twist Table, No. 2.

Lbs. weight per Spl	At the rate for 3 lbs of 7·5	Lbs. weight per Spl	At the rate for 3 lbs of 8·5	Lbs weight per Spl	At the rate for 3 lbs. of 9·5	Lbs weight per Spl.	At the rate for 3 lbs. of 10·5
2	9·18	2	10·41	2	11·34	2	12·86
2¼	8·66	2¼	9·81	2¼	10·97	2¼	12·12
2½	8·21	2½	9·31	2½	10·4	2½	11·33
2¾	7·83	2¾	8·87	2¾	9·92	2¾	10·96
3	7·5	3	8·5	3	9·5	3	10·5
3¼	7·2	3¼	8·16	3¼	9·12	3¼	10·08
3½	6·94	3½	7·86	3½	8·8	3½	9·72
3¾	6·7	3¾	7·6	3¾	8·5	3¾	9·39
4	6·49	4	7·36	4	8·22	4	9·09
4¼	6·3	4¼	7·13	4¼	7·98	4¼	8·82
4½	6·12	4½	6·94	4½	7·77	4½	8·57
4¾	5·96	4¾	6·75	4¾	7·54	4¾	8·34
5	5·81	5	6·58	5	7·36	5	8·13
5¼	5·67	5¼	6·42	5¼	7·18	5¼	7·93
5½	5·54	5½	6·27	5½	7	5½	7·75
5¾	5·41	5¾	6·14	5¾	6·85	5¾	7·58
6	5·3	6	6	6	6·7	6	7·42
6¼	5·19	6¼	5·89	6¼	6·6	6¼	7·27
6½	5·08	6½	5·77	6½	6·45	6½	7·13
6¾	5	6¾	5·67	6¾	6·34	6¾	7
7	4·91	7	5·56	7	6·21	7	6·87
7¼	4·82	7¼	5·47	7¼	6·11	7¼	6·75
7½	4·74	7½	5·37	7½	6·08	7½	6·64
7¾	4·66	7¾	5·29	7¾	5·92	7¾	6·53
8	4·59	8	5·2	8	5·81	8	6·43
8½	4·55	8½	5·05	8½	5·64	8½	6·24
9	4·33	9	4·90	9	5·48	9	6·06
9½	4·21	9½	4·77	9½	5·34	9½	5·90
10	4·10	10	4·65	10	5·20	10	5·75
10½	4	10½	4·54	10½	5·10	10½	5·61
11	3·91	11	4·43	11	4·96	11	5·48
11½	3·83	11½	4·35	11½	4·85	11½	5·36
12	3·74	12	4·25	12	4·75	12	5·25
13	3·6	13	4·08	13	4·56	13	5·04
14	3·47	14	3·93	14	4·39	14	4·86
15	3·35	15	3·80	15	4·25	15	4·69
16	3·24	16	3·68	16	4·11	16	4·54
17	3·15	17	3·57	17	3·99	17	4·41
18	3·05	18	3·47	18	3·88	18	4·28

FLUTING.

WE now come to the fluting of the boxwood rollers, a subject the importance of which we have noticed in the "Wet Spinning Room" section of this book. The importance of having the rollers properly fluted cannot be overrated, and this necessitates the exercise of the greatest care. Fluting machines are very simple in their construction, and one would naturally be inclined to think there was very little liability to err with them. The very slightest derangement, however, in the machine will cause damage to the roller, and, as we have already shown, very slight defects in the flutes affect the spinning. The bosses are cut of various diameters and breadths, according to the pitch of frame, &c. The bosses should be cut a shade less in width than the brass boss they are intended to run on. In fine numbers, however, the boss should be fully the width of the brass one, and this keeps the brass roller well wet. If the boss of the roller be much wider the edge of the brass roller cuts the wooden one, and in a short time spoils it. The bosses require to be steeped in water to prevent cracking after they are placed in the frames. Another method is to boil or steam them for a few hours, allowing them to cool, and afterwards use them. Another method is to place them in cold water and allow them to get thoroughly saturated. We prefer cold water steeping, for several reasons. After steaming or boiling a great many of the bosses crack and become useless, and are liable to break down in working. The grain of the wood expanded by the heat after the boiling seems to remain open, and the flutes have never the same clean surface as in the case of cold water steeping. The boiled bosses do not, for the reasons we have given, run so long in the frames. The next question is, How long should the bosses

be steeped in cold water? If they are put on, say, after a week in water, the tendency, unless the cutter is kept extremely sharp, is to make a rough flute, and if put into the frames without being thoroughly saturated they are likely to be thrown off the "centre." My opinion is that they should be steeped about four or five weeks. As the water emits a strong smell when steeping, and dirt collects, it should be run off occasionally. The rollers when running in the frame will gather a thick coating of dirt on their sides, which should be regularly washed off every time they are to be refluted. This dirt, if allowed to remain, makes the wood soft, so that the rollers will not stand without refluting so long as otherwise they would do. These remarks apply to boxwood, as it is most generally used, but we have other woods used for rollers, as well as gutta-percha. The latter, however, is seldom used. Holly timber and laurel are used when obtainable at a reasonable cost, and suit very well for tows or wefts. They are sometimes used green, but are better to be steeped in the log and then cut. Thorn is also used, as mentioned in "Spinning." Bossing or putting the wood on the axles is a very simple process, care being taken to have both bosses the same size, and to have them screwed on tight. The rollers being fluted with various flutes and diameters, gauges showing the diameter and number of flutes on the roller must be used. The coarsest generally used is 24 flutes per inch. The phrase as to "flutes per inch" applies to diameter. Thus, in a roller "24 flutes per inch," being 2 inches in diameter, you have 48 flutes, in a roller 3-inch diameter (24×3) you have 72 flutes. In rollers 30 flutes per inch you have the same thing, a 2-inch diameter roller having $(30 \times 2) = 60$ flutes. In refluting, some people, by means of a small slide lathe, take off the old flutes and then reflute them, others simply put the rollers into the machines as they are. The latter is a little more severe on the cutter, but is practically the more simple plan. In refluting you reduce the diameter of the roller, and generally require to have 3 flutes less

every refluting of the roller, and 3 flutes, if these are 24 per inch, $= \frac{1}{8}$ inch of diameter less each time the roller is refluted; in 27 flutes per inch 3 flutes $= \frac{1}{9}$, in 28 flutes per inch 3 flutes $= \frac{3}{28}$, in 30 flutes per inch 3 flutes $= \frac{1}{10}$, in 32 flutes per inch 3 flutes $= \frac{3}{32}$, in 36 flutes per inch 3 flutes $= \frac{1}{12}$, in 40 flutes per inch 3 flutes $= \frac{3}{40}$, &c. Fluting machines are furnished with an index wheel for each diameter, so that you can put on what flutes are required. On the opposite page we give a table showing the number of flutes or index wheel for each diameter.

TABLE SHOWING NO. OF FLUTES OR INDEX WHEEL FOR EACH DIAMETER.

Diameter of Roller.	No. of Flutes for 24 inch.	Diameter of Roller	No. of Flutes for 27 inch.	Diameter of Roller.	No. of Flutes for 28 inch	Diameter of Roller	No of Flutes for 30 inch	Diameter of Roller	No of Flutes for 32 inch	Diameter of Roller	No of Flutes for 36 inch.	Diameter of Roller	No. of Flutes for 40 inch
1	24	1	27	1	28	1	30	1	32	1	36	1	40
$1\frac{5}{8}$	39	$1\frac{5}{9}$	42	$1\frac{12}{28}$	40	$1\frac{4}{10}$	42	$1\frac{15}{32}$	47	$1\frac{3}{12}$	45	$1\frac{12}{40}$	52
$1\frac{3}{4}$	42	$1\frac{6}{9}$	45	$1\frac{15}{28}$	43	$1\frac{5}{10}$	45	$1\frac{18}{32}$	50	$1\frac{4}{12}$	48	$1\frac{15}{40}$	55
$1\frac{7}{8}$	45	$1\frac{7}{9}$	48	$1\frac{18}{28}$	46	$1\frac{6}{10}$	48	$1\frac{21}{32}$	53	$1\frac{5}{12}$	51	$1\frac{18}{40}$	58
2	48	$1\frac{8}{9}$	51	$1\frac{21}{28}$	49	$1\frac{7}{10}$	51	$1\frac{24}{32}$	56	$1\frac{6}{12}$	54	$1\frac{21}{40}$	61
$2\frac{1}{8}$	51	2	54	$1\frac{24}{28}$	52	$1\frac{8}{10}$	54	$1\frac{27}{32}$	59	$1\frac{7}{12}$	57	$1\frac{24}{40}$	64
$2\frac{1}{4}$	54	$2\frac{1}{9}$	57	$1\frac{27}{28}$	55	$1\frac{9}{10}$	57	$1\frac{30}{32}$	62	$1\frac{8}{12}$	60	$1\frac{27}{40}$	67
$2\frac{3}{8}$	57	$2\frac{2}{9}$	60	$2\frac{2}{28}$	58	2	60	$2\frac{1}{32}$	65	$1\frac{9}{12}$	63	$1\frac{30}{40}$	70
$2\frac{1}{2}$	60	$2\frac{3}{9}$	63	$2\frac{5}{28}$	61	$2\frac{1}{10}$	63	$2\frac{4}{32}$	68	$1\frac{10}{12}$	66	$1\frac{33}{40}$	73
$2\frac{5}{8}$	63	$2\frac{4}{9}$	66	$2\frac{8}{28}$	64	$2\frac{2}{10}$	66	$2\frac{7}{32}$	71	$1\frac{11}{12}$	69	$1\frac{36}{40}$	76
$2\frac{3}{4}$	66	$2\frac{5}{9}$	69	$2\frac{11}{28}$	67	$2\frac{3}{10}$	69	$2\frac{10}{32}$	74	2	72	$1\frac{39}{40}$	79
$2\frac{7}{8}$	69	$2\frac{6}{9}$	72	$2\frac{14}{28}$	70	$2\frac{4}{10}$	72	$2\frac{13}{32}$	77	$2\frac{1}{12}$	75	$2\frac{2}{40}$	82
3	72	$2\frac{7}{9}$	75	$2\frac{17}{28}$	73	$2\frac{5}{10}$	75	$2\frac{16}{32}$	80	$2\frac{2}{12}$	78	$2\frac{5}{40}$	85
$3\frac{1}{8}$	75	$2\frac{8}{9}$	78	$2\frac{20}{28}$	76	$2\frac{6}{10}$	78	$2\frac{19}{32}$	83	$2\frac{3}{12}$	81	$2\frac{8}{40}$	88
$3\frac{1}{4}$	78	3	81	$2\frac{23}{28}$	79	$2\frac{7}{10}$	81	$2\frac{22}{32}$	86	$2\frac{4}{12}$	84	$2\frac{11}{40}$	91
$3\frac{3}{8}$	81	$3\frac{1}{9}$	84	$2\frac{26}{28}$	82	$2\frac{8}{10}$	84	$2\frac{25}{32}$	89	$2\frac{5}{12}$	87	$2\frac{14}{40}$	94
$3\frac{1}{2}$	84	$3\frac{2}{9}$	87	$3\frac{1}{28}$	85	$2\frac{9}{10}$	87	$2\frac{28}{32}$	92	$2\frac{6}{12}$	90	$2\frac{17}{40}$	97
$3\frac{5}{8}$	87	$3\frac{3}{9}$	90	$3\frac{4}{28}$	88	3	90	$2\frac{31}{32}$	95	$2\frac{7}{12}$	93		
$3\frac{3}{4}$	90	$3\frac{4}{9}$	93	$3\frac{7}{28}$	91	$3\frac{1}{10}$	93	$3\frac{2}{32}$	98				
$3\frac{7}{8}$	93	$3\frac{5}{9}$	96	$3\frac{10}{28}$	94	$3\frac{2}{10}$	96						
4	96	$3\frac{6}{9}$	99	$3\frac{13}{28}$	97								
$4\frac{1}{8}$	99	$3\frac{7}{9}$	102										
$4\frac{1}{4}$	102												

The gauges should all be stamped with the diameter and number of flutes required, which is given in the preceding table, so that the boy attending the machine, having collected a quantity of rollers of the same size to flute to a certain gauge, may see the number of flutes on the gauge which that diameter requires, and put on the corresponding index wheel. The importance of having the rollers properly done cannot be too strongly impressed, as they may be the cause of a great amount of unnecessary trouble to overseer and spinner, even when the defect in the roller may be so trifling as not to be noticeable except under close examination. Now, in order to work or superintend fluting machines you must first understand what is a good roller, as described in "Spinning," and then the manner in which the various faults are caused. In putting the cutter into the machine, a plumb line should be run over the cutter hanging from the centre of the flute in the cutter, and screwing out the centre the cutter should be moved until the plumb line is exactly in line with the centre. Sometimes you will find a small cut at the bottom of the flute. This is caused by a little burr being left on the side of the cutter, which should have been taken away after being re-turned in a lathe by the cutter tool. If your cutter is put on the arbor or stud and allowed any movement on it the flutes will be cut away at the side after being fluted. The greater the movement the more easily it is detected, and with little movement it is sometimes puzzling, so that care should be taken to set the cutter properly and allow merely freedom to revolve. Another defect is caused by the cutter arbor being worn, and when you hold the roller lengthways and look along the flutes they appear waved, and, although the flutes may be perfect in other respects, they will not bear evenly. The indices must be all evenly pitched, otherwise your flutes will not be equal, some being wider than others. Dirt in the teeth has the same effect, so that they should be regularly brushed. Uneven pitched flutes are often caused by the axle which carries the index wheel being too slack, and so the lift

motion of the machine sometimes turns it irregularly. It is not necessary to screw the bushes extremely tight, as that, combined with the collar of the axle pressing against the bush when a roller is screwed in, makes the machine too stiff. All that is required is that it should be so tight that the "kicker" will not throw the index wheel further than it lifts itself. The gauge should be tried occasionally after fluting on both bosses, lest there should be any difference in their size. If the centres are not exactly in line this will be the case, and of course it will make a very indifferent roller. It is remedied in this way: If the boss next the index be too small, lower the centre, by lowering the bushes which carry the index axle, until you find both bosses flute to the same size. If it be too large, raise the bushes, by placing under them a small piece of tin or brown paper. Before placing the roller upon the centres to flute, the small holes in the roller axle should be picked, if dirt has filled them up, otherwise the roller will be apt to run off the centre when fluting. Another cause of this is the centre in the index head wearing and having too much freedom. The centres should also be turned up when they become blunt. The kicker, or lift motion, varies in different machines. Some lift the index as the roller is going forward, others lift the index when coming back, and it is thus fully lifted when at the extreme end. Preference is generally given to machines that lift just after turning to go forward to the cutter, because the lift is more gentle. The lift, or kicker, after turning, and before any force is on, catches the bottom of the inclined plane, and is pressed upward until it reaches the level surface, when it travels forward without further movement of the index motion, dropping when it comes back to the end again. In the other method the kicker strikes with force after travelling from front to back. On stopping to change rollers it will be found after the machine has had a little wear that the kicker does not stop close to the tooth, and unless before starting the index is turned close back to the kicker there will be a small flute in the roller. Inde-

pendently of this the bushes require to be screwed too tight to counteract the force of the blow. After the cutter is turned up (which is generally once a week) the face of the teeth should be filed, and also when it gets blunt—say, on alternate days—the front or cutting part of the teeth must be filed square or in line with the centre.

REELING.

LOOKING at the duties of reeling overseers one is disposed to sympathize with them, if they are anxious for promotion, from the want of opportunity to display their abilities. The yarn is made before it comes to them, and the mischief, if there be any, is done. But "never too late to mend" is an old saying, and the reeling overseer has great power in checking bad work and errors, and preventing their recurrence. There is no greater comfort to a manager, and no one can assist him more, than a good reeling overseer, and a bad one is a sad affliction. A manager cannot possibly see all that goes on, and the constant liability of yarn to get mixed before or after leaving the spinning room, or the liability to pass light, heavy, or beaded yarn, and the hundred and one other risks that are ever present, make it an imperative duty on the part of an overseer to be always on the outlook. When the manager goes to the reeling room, instead of having to look for faults, or, what is ten times worse, bring samples of them in his pocket from the customers, he should hear a report from the overseer what is wrong, and have it righted, if this has not already been done.

First then, the overseer should become acquainted—and we will suppose he is—with the Yarn Table given at the end of this book. That the overseer should be a judge of yarn is essential, and practical experience is the only way to this attainment. He should make an inspection of each reeler's yarn as often as possible for the purpose of seeing if it is right, and this serves at the same time as a check on bad reeling. A constant outlook for bad piecings is necessary, as inexperienced hanks are often introduced in the spinning rooms. Another imperfection, which appears similar to an ordinary bad piecing, but is infinitely worse, is the formation of a double thread by two running together. By

untwisting this double thread a small piece will come away without affecting the proper thread. A similar defect may be caused by the spinner when putting up an end not taking the waste entirely off the roller.

Beading is one of the worst things that can remain unchecked, as the yarn is almost useless; but any overseer will easily detect this. Lumps or swells occur in some yarns from the nature of the material from which they are made, but a kind of lump may and often does occur which should not. This is the waste lump, made in both preparing and spinning rooms. An easy way to decide to which variety the lumps belong is to send them to the spinning overseer. If he has got his wits about him he will not care to be saddled with what does not belong to him. But you may easily satisfy yourself what they are, and where they were made, if you open up one of these swells, which, I may add, occur chiefly in low numbers. Naps, as those in the higher numbers are called, differ from ordinary tow lumps in their comparative smallness. If they were originally in the dressed flax, or made in the preparing before the roving, they are generally inside the thread; if at the roving, they are usually on the outside. If made in the spinning, through dirt in the troughs or otherwise, they are made up more of small dirty shives, which adhere to the rove, and are on the outside of the thread. Mixtures are generally easily detected by the difference in colour. Heavy yarn, which may only appear in a cut or part of one—and the same applies to light yarn—should be strictly looked after. The overseer should train his reelers to pick out these things, so as to make it almost impossible for any to pass. But here is the difficulty: a reeler, while she may readily take out a small bobbin which will not reel, may prefer when a heavy one has run a few times round to save trouble by letting it go, and so with all other defects. Then, what is to be done when yarn is sent back from the drying or bundling? The overseer cannot know the reeler, nor the frame number to which it belongs. An easy way to deal with this difficulty is to have a number of stout paper tickets with

numbers printed on them, and a hole in each ticket to tie on to the leasband, one ticket being on every quarter reel, half reel, or reel, as may be thought best. The ticket need not be more than $\frac{1}{4}$ inch or $\frac{3}{8}$ inch square. They should be made in sheets printed with the numbers at regular intervals, and a hole cut beside each, similar to the way cards for looms are cut. When you get yarn back, having any fault you have the ticket, and know where to go, and each reeler should have a number which she should keep, no matter what yarn she may reel. Reelers should be careful in taking their yarn from the reels to prevent breakage, or rubbing against the end of the swift and getting it oiled.

Wet spun yarn if allowed to lie long before being reeled will get damaged by rotting, and care should be taken to have them reeled systematically. No damage will ensue to bobbins lying from Saturday till Monday, but in case of longer stoppage they should be all reeled up. Heavy tow yarns lying three days will be damaged, especially that part next the bobbins; in fact, no yarn should be left unreeled longer. Overseers by experience are able to tell by the bulk of a certain number of hanks in their hand whether the yarn is too heavy or too light for the size intended, and so check any error that may occur through mistaken pinions being put on in the spinning room. The first of a new number should be checked in this way. Good light is essential, more especially for fine yarns, and should be obtained from skylights. In addition to being well lighted, reeling rooms should be kept warm, as reelers sometimes do their work badly through the wind from the reels benumbing their fingers. The importance of correct counting is evident. In the bell wheel, one, two, or three teeth are added, making 121, 122, or 123, so as to make up for any revolutions the reel may make after a bobbin is empty before the reel is stopped.

Whatever system may prevail, I would strongly advocate the use of means to prevent the counters having any knowledge of whose yarn they are counting, as

sometimes they display in their counting friendliness to the reeler, or the reverse.

Leasing, Knot, &c.—The proper knot is technically termed the "weaver's," which leaves both ends separated, and what is known as the "thumb knot" must be carefully avoided, as it leaves both ends together with sometimes a loop, which in warp sticks at the weaver's reed, and in wefts causes an ugly lump. Leasing should be accomplished so as to leave freedom for the cuts to be spread in bleaching without being so loose as to get entangled and similar in appearance to cross reeling.

When the end is to be tied in with the knot on the leasband at the end of the hank care should be taken that it is tied so that it will not pull out.

Construction of Reel.

The reel is a machine of much importance, which, perhaps, from the simple nature of its construction is apt to be overlooked at first. The two main things to be borne in mind to render reeling perfect are—first, to observe that the diameter of the reel is in all cases perfectly correct, that it is made to run true, and is evenly balanced; and, second, that the yarn is spread across the reel as equally as possible, otherwise there will be great differences in the length of the yarn, which will cause much trouble and annoyance when shaking it out during the bleaching process. The common make of reels is called telescope. They are malleable iron tubes from centres, with 4 sets of 8 spokes each, for carrying the yarn rails. The spokes are made of hardwood and the rails of yellow pine. The rails are kept asunder at equal distances by means of tapes fastened on their under side. Rings are attached to the tapes, which slip over small knobs to secure the reel or detach it, as may be required, when the yarn is ready to be stripped off the reel. It is driven by means of a friction boss covered with leather, which, when pressed against a plate, sets the reel in motion. This motion is controlled by means of a footboard which the

reeler presses downwards so long as it is required to be kept running, removing the pressure when she wishes it to stop. In some places, when the board is pressed, the reel stops, but the former way is the more common method. The bobbins are always put on upright sockets in wet spinning and the finer numbers of dry spun yarns, but the heavy numbers are also reeled while the bobbin is lying horizontally.

Yarn Bundling.

Wet spun yarns are made up variously; in long bundles if for short conveyance, but more generally in press bundles. If in long bundles, a stool is used having three or four steel pins at each end, with a distance between, so as to allow the yarn to be stretched from one side to the other, tied with five or six hanks, and the bunch generally weighs about 40 lbs., the number of hanks depending on the size of the yarn. In bundling dry spun yarns the long bundle is universally adopted.

Press Bundles.--These are made up in the following way:—

Lea.	Quantity in Press Bundles.	Hanks in Press Bundle.	Heads in Press Bundle	Hanks in each Head.	Number of Bands	Hanks in each Band.
10 to 20	$1\frac{1}{2}$	25	12	2	4	$\frac{1}{4}$
20 to 22	3	50	$24\frac{1}{2}$	2	4	$\frac{1}{4}$
25 to 38	3	50	16	3	4	$\frac{1}{2}$
40 to 78	6	100	16	6	4	1
80 to 160	12	200	24	8	4	2

Yarn Drying.

This is a branch only required in wet spinning, as the yarn after being reeled still retains the moisture which it absorbs from the hot water troughs in the

spinning room. How to dry the yarn and so leave it in a fit state for bundling, &c., in the best possible way, has been a disputed subject for a long time. This process was at first accomplished in the open air, but as mills extended this mode was found too slow. Various means were tried a number of years ago for the purpose of lessening the cost and inconvenience. Drying machines were invented. These were constructed in the shape of a square box, generally taking in a frame the width of the yarn stretched from one side to the other. These frames, as they were filled, were lifted to the top by a pulley and pushed through a small folding door into the box, the lowest one being taken out at the same time, and the rest lowered so as to allow room for the one inserted. In connection with the bottom of this was generally a tubular boiler for air heating, and a fan placed on the top of the yarn enclosure drew the hot air up through the frames on which the yarn was stretched, and thus carried off the moisture. The yarn generally took three-quarters of an hour to dry. Another kind of drying machine was an arrangement of cylinders similar to the machine still used for drying cloths at bleachfields. Steam being introduced into the cylinders, the yarn was made into a continuous chain by being spread on a brass or copper rod and attached to the end of the yarn preceding, in which was placed another rod with a link, and so on. The yarn was passed over these machines in a space of from 45 minutes to one hour. In a few places drying is accomplished before reeling by placing the bobbins on stands and putting them into heated presses.

Neither of these methods seems to us to be the proper one, and we will give reasons for this opinion after describing the mode generally in use in connection with wet spinning mills at the present time. The way in which yarn drying is now accomplished is by means of large steam pipes passing round the floor under the yarn, which is hung on booms or poles. The pipes when above the floor prevent the person handling the yarn from moving freely about, and, besides, the bottom

of the yarn hangs too near the pipes, especially if the heat be high. Others place the pipes below an open or sparred floor, provision being made for cleaning the caddice or flowings off the pipes. This arrangement is very convenient, as it enables the yarn dryers to have free access to the yarn, but great care must be taken to keep the pipes clean; if this is not done the heating power is greatly lessened. With regard to the temperature most suitable for yarn drying, we would say that it is best to dry with as low a temperature as possible. If it were practicable, drying in the open air, as was formerly done, is the best when the quantity is small and the numbers light. As this is impracticable where large quantities are turned off, and especially in the coarser trade, drying rooms must be introduced. The heat in these rooms or stoves should just be kept as low as convenient, and should never exceed, say, 80 deg. to 90 deg.[*] Fahrenheit. When the steam is turned on all ventilation should be closed until the atmosphere becomes charged with moisture; the ventilators should then be opened sufficiently to carry off the moist atmosphere during drying. Ventilators opened before this, or opened too much, wastes the drying power "heat." From want of sufficient accommodation we have seen yarn hung during the day, steam turned on at, say, six o'clock in the evening, shut off at two or three o'clock the following morning, and the yarn taken off at six o'clock the same morning to make room for a fresh supply. In order to have it dried in such a short space of time the heat was required to be forced up to, say, 120 deg. Fahrenheit; and what was the result? All flaxes contain a certain amount of oil, which is known generally by the name "quality." The heat thus brought to bear upon the yarn, and which should only evaporate the water taken from the spinning, evaporates also this oil which it contains, and the result is a dry, harsh, and brittle yarn. In the case mentioned our attention was attracted by some fire pails filled with water along the side of the drying room, and which carried on the surface, besides the dust, a certain amount of oil. On taking up the

dust and rubbing it between our fingers it felt greasy. The pails being filled with clean water, next morning the oil was plainly visible, and could be detected at once by the mixture of colour on the water. Now, if in a single drying a fair coating is deposited on the water, a very great quantity must disappear through the ventilators. This is of vast importance, as the object to be aimed at in drying is to retain as much as possible of this natural substance or "quality." We may take away by cooling, damping, &c., the harsh "feel," and to a small extent the brittleness of the yarn, but we have no means of imparting this oil or "quality," which gives it an elasticity without which it is defective, and which gives it the appearance and touch of a good article. Looking back at the first mentioned modes, it will be seen that the great objection to all of them is too quick drying. The first leaves a nasty crimp where it is attached to the frame. In the second a similar crimp is formed, owing to the brass rod, which it is impossible to get entirely out, although the steam cylinders give the yarn a glazed appearance, which may be mistaken for "quality." In the third case, drying on the bobbins is only adopted to save reeling where the yarn goes direct to the weaving. It will be seen that before the yarn next the barrel of the bobbin is dried the outside will have received far too much heat, leaving no chance of slow and gradual cooling, so that the yarn is certain to be brittle.

Having disposed of the drying, or heat, and means of applying it, let us consider how the yarn should be hung in the drying room. Heat causes hanks of yarn hanging loosely from a boom or pole to become twisted. We must use means to prevent this as far as possible, and so obtain equal drawing. The threads, especially where too hastily dried, have the twist curled out at short intervals. The best way, where practicable, is to have spare swifts or reels and dry the yarn before taking off. The yarn is dried in this way while still stretched, and, although it gets loose as it dries, very little curling takes place. We have known

this mode to be adopted, but as it would be impracticable in the majority of cases we must look at the next best way. This is to suspend a boom in the hanks, the weight of which prevents a good deal of the untwisting. The labour of doing this may be urged against it, but labour is afterwards saved in shaking, &c.

The effect may be very readily seen in drying twist, which without the boom in the bottom opens up very much. The yarn should be spread on the two booms, then one placed in the bottom, and the top one turned round once or twice to allow the lower one to bear evenly all along. They should also be turned at intervals during drying, to prevent the part resting on the boom being unequally dried This will not prevent all the untwisting, and so something must be done to take it entirely out. The yarn should be shaken with the hand on being placed on the boom wet, but not severely, otherwise a roughness or hair is raised. It should afterwards be turned during drying, and shaken with a wooden pin when almost dry until straight. In shaking, the yarn requires to be caught by the pin in different parts. To bring the yarn round the boom is a difficult thing to do without breaking or teasing it. Standing with the two feet and the body at right angles to the boom, with three, four, or more hanks upon the pin used for shaking, the arms are raised, not by a forward motion, but rather with an upward circular motion, and the yarn brought with a stroke to full stretch. This, so far, is simple. but to bring the yarn round to shake it in a different position is not so simple. Grasping the pin on each side, the yarn should be held at full stretch. The top and bottom part of the hank between the pin and boom are almost close. With a sudden motion, jerk upward the upper part of the hank, and, when thus separated, pass the pin parallel between the top and bottom, raising the top part of the hank at the distance you want the yarn pulled round. This lifting gives a swing to the under part, freeing its hold on the back of the boom, and making it come round quite easily without disturbing a single thread.

The difference is seen more readily in wet yarn, for while an unpractised hand may turn dry yarn, it is impossible for him to do so if it be wet, as without the swing the wet yarn adheres, and will not draw without teasing. Yarn contains a certain amount of moisture, and without this it would feel dry and harsh, especially if deficient in natural oil or "quality," and it should be allowed to hang after shaking for twenty-four hours or more with windows opened to admit a free current of air. After this it should be allowed to lie in some cool place about a week, if possible, before bundling. As in every mill there is not a place properly adapted for cooling, damping by means of a water rose is substituted. The amount of water which yarn should contain to be in a pliable and proper condition depends upon the precise nature of the material. It will be found that warps made from good material will not require so much water as wefts, the reason being, as stated before, that good material, having more oil than the poor material, does not require so much moisture to bring it to the same state of pliability. The poorest yarn will not receive more than 5 to 7 per cent., and better qualities 3 to 5 per cent. of water. To put in more than this would be running the risk of rotting it if stored, and giving it the weight of a heavier yarn than it really is. Of course, the better it is cooled before coming to this stage the less damping will it require, and the percentages given indicate the difference between a very dry and a saleable condition. Yarn going direct to the looms is sometimes shaken after damping, and slightly "pinned," for the purpose of securing still more pliability.

JUTE SPINNING.

JUTE: ITS CULTIVATION AND TREATMENT PRIOR TO SPINNING.

THE jute plant belongs to the Corchorus family, and the two species from which the fibre is principally derived are—*Corchorus olitarus* and *Corchorus Capsularis*. Most of the fibre is obtained from the latter. The cultivation of the plant is similar in many ways to that of the flax plant, which has been previously described. The jute fibre is obtained chiefly from British India, where within recent years the cultivation has extended to a very great extent. In Sanskrit the plants are called *putta*; in Bengalese they are variously called *pat*, or *paut*, and *Ghi-nalita pat*. The fibre is called *jute*, and the cloth *chotte* or *choti* (this name being the supposed origin of the word jute). The cloth is called *tat*, and *megila*. The plants resemble each other very closely, and are cultivated, not for the fibre only, but also for the leaves, which are used as pot-herbs by the Hindoos and Mussulmans. They are also used as pot-herbs in Egypt, Arabia, and Palestine.

The plants under cultivation grow to a height of six, eight, or ten feet, and in rich soil attain a height of from twelve to fifteen feet. The stem is straight and smooth, with an average circumference of one inch. The stem throws out lateral branches, the number of which depends, as in the case of the flax crop, upon the degree to which they are crowded by the other plants. The two species may be thus described.

Corchorus olitarus.—The stem is erect, smooth, and

more or less branched. The branches appear near the top of the plant, and bear leaves of a bright green colour, toothed on the margin, and of a somewhat oval shape. The stipules are narrow, and of a reddish tinge at the base. The flowers, which appear singly or in pairs on the stalks, are rather small and symmetrical in calyx and corolla, each consisting of five parts. The petals are yellow, and have honey glands at their base. The pistil is syncarpous, and contains many seeds.

Corchorus capsularis—This species is almost similar A slight difference may, however, be observed when the several parts are closely examined. The leaves are more pointed, serrate rather than dentate, and are of a lighter green. Perhaps the most distinguishing feature is the capsule, which is short and round, while in the other it is elongated and cylindrical. Both plants flower in the rainy season, and the fruit is ripe in September and October.

The jute plant, or plants, may be grown in any country where there is sufficient warmth and moisture. It is cultivated much more in India than any other fibrous plant, and is an important source of revenue to that country. It is most extensively grown in the alluvium, in the deltas of rivers, and also, though not to such an extent, on the higher grounds. A rich loam formed by the overflowing of the rivers is very suitable for its cultivation. The jute seed is sown principally in March and April, and sometimes in May. The fields are weeded after the plants attain a height of about one foot. When the plants flower, in August or September, they are cut down. If, however, seed is to be preserved, the plants are left for a longer time to bring them to maturity. The plants, which are now large stalks resembling willows, are tied up in bunches preparatory to the steeping process. Large shallow tanks are formed, into which the bunches are placed, and kept under water by weights. The rotting process occupies from ten to twenty days, and requires careful watching lest the fibre receives injury. When the fibre can be easily removed

from the wood stalk, it is taken out. Before being dried the stalks are broken about two feet from the end, placed in bunches of eight or ten, and the fibre is stripped off. The fibre is then washed and hung over bamboos to dry in the sun. After the drying process it is cleaned and tied up into bundles for the market. The jute is bought by dealers and shipped to Calcutta, where it is made up into bales and reshipped to this country. These bales are formed in hydraulic presses, which economise space, and thus enable ships to take larger cargoes than formerly, when the bales were formed in hand presses, and cargoes had to be made up with some heavier material.

Introduction of Jute to Europe.

Jute is now so largely used, and the material made from it so well known, that we are apt to suppose its manufacture must have been long established in this country. This, however, is not the case, although in India it has been known for a long period, during which it has been made into cordage, cloth, &c. The gunny bags in which rice was exported was made from this material. Jute was not known in Dundee, now the principal seat of its manufacture, until 1824. Attention, however, was drawn to the jute fibre as likely to be serviceable to linen manufacturers and others as far back as the close of the eighteenth century.

In the beginning of last century small quantities were imported into Britain, but they were not turned to profitable account. In 1832 it was successfully manufactured in Dundee, being mixed at first with flax, tow, or coarse codilla. In this year there was imported into Dundee 182 tons. The manufacture gradually developed, but it was not used in very large quantities for some years later. In 1851 there was exported from Calcutta 29,120 tons, and at the present time the exports reach considerably over 200,000 tons annually. From these figures will be seen the rapid growth of jute manufacture. The great secret of this may have been

its cheapness and the practicability of manufacturing it by means of machinery already in existence. On its introduction it was thought possible to make it into goods as fine as cambric, but this was subsequently found to be impracticable, hence it has been principally used in the manufacture of coarse goods, sacking, &c. At the present time, however, a small proportion is made into line yarns for window drapery, paddings, &c., being hackled and spun in the same way as flax. The great bulk, however, is converted into jute tow and spun into heavy yarns, from which a great many varieties of goods are made, sacking being the principal. Jute sacks are used for the importation of cotton, grain, and other stuffs. It was at first supposed that jute yarn could not be bleached, but this difficulty has been overcome; and as it is not necessary, owing to the nature of the manufactured goods, to produce high colours, the lower bleached goods are commonly made. Jute yarns are easily dyed, and are much used, both in single and twisted yarns.

The consumption of jute in the United Kingdom has been almost stationary for over twenty years, and the trade has been mainly confined to Dundee and the surrounding district.

On the Continent consumption has largely increased during that period, but by far the largest increase has been in India. The production of cloth in Calcutta has extended enormously, being now over four times what it was in 1884.

The following tables will show the growth of the trade, and also the estimated consumption of jute for the past season, 1905-1906:—

STATISTICS OF CONSUMPTION OF JUTE, REJECTIONS, AND CUTTINGS.

	1874.	1884.	1894.	1904.
Consumption.	Bales.	Bales.	Bales.	Bales.
United Kingdom,	1,000,000	1,200,000	1,200,000	1,200,000
Continent,	300,000	650,000	1,100,000	1,800,000
America,		500,000	500,000	500,000
Indian Mills,	460,000	900,000	1,500,000	2,900,000
Local Indian Consumption,		500,000	500,000	500,000
Total Jute Crop Consumption,		3,750,000	4,800,000	6,900,000

ESTIMATED CONSUMPTION OF JUTE, 1905–1906.

	Bales per Annum.		Bales per Annum.
Scotland,	1,150,000	Norway and Sweden,	62,500
England,	40,000	Russia,	180,000
Ireland,	20,000	Holland,	25,000
France,	475,000	Spain,	90,000
Belgium,	120,000	Italy,	160,000
Germany,	750,000	America,	550,000
Austria and Bohemia,	262,000	India,	4,200,000

Jute Batching.

Jute was formerly imported in bales weighing 300 lbs., afterwards increased to 350 lbs., and at the present time they average in weight about 400 lbs. each. The bales are now pressed for shipment by hydraulic power. The streaks caused by the pressing of these bales are very hard, and are consequently somewhat difficult to open and split into workable size. In some cases the bales are placed under a steam hammer and subjected to a beating process for a short time, the jute ropes which bind the bales being all cut except a few necessary to keep it together. Another machine is in some places used for this purpose; it is called a crushing machine. It consists of three crushing rollers made with blunt teeth. The rows of teeth in the upper roller intersect grooves in the two lower rollers, and the latter intersect those of the upper roller. By this means the strands are separated. Where neither of these means are adopted, and if the jute is not to be hand-batched, it is passed at once through a softening machine, to which we shall presently refer From the nature of the jute fibre it requires to undergo a softening process somewhat similar to hemp, and it is necessary to spread thinly over it a mixture of oil and water, or some other suitable substance. This serves several purposes, amongst others making it pliant and workable by the machinery through which it subsequently passes. The proportion of oil and water varies considerably. The quantity of water varies according to the temperature and state of the atmosphere, the time and mode of application, and the nature of the material under process. The quantity of oil, however, does not vary so much as the quality, which is made lower for the cheaper material used for heavy yarns. The water and oil are generally heated to a temperature of, say, 90 deg. to 100 deg. Fahrenheit. In some cases the oil is applied cold, and some even use both without being heated. Whale and seal oil, with a proportion of mineral for cheaper yarns, is what

is commonly used, but a great variety of mixtures may be found in use. The following, however, may give a general idea of the mixtures and proportions applied:—

For 1 *Bale of, say,* 350 *lbs.*

FINE JUTE YARNS.

No. 1	No. 2.
$\frac{3}{8}$ gallon whale oil.	$\frac{1}{3}$ gallon whale oil.
$\frac{3}{8}$,, seal oil.	$\frac{1}{3}$,, seal oil.
$\frac{1}{4}$,, mineral oil.	$\frac{1}{3}$,, mineral oil.
5 to 7 gallons water.	5 to 7 gallons water.

COARSE JUTE YARNS.

No. 1.	No. 2.
1 gallon mineral oil.	$\frac{7}{8}$ gallon mineral oil.
5 to 6 gallons water.	5 to 6 gallons water.

For a Batch of 19 *Bales of* 400 *lbs. each.*

FINE JUTE YARNS.

No. 1.	No. 2.
8 gallons whale oil.	5 gallons whale oil.
8 ,, seal oil.	5 ,, seal oil.
3 ,, mineral oil.	$4\frac{1}{2}$,, mineral oil.
100 ,, water.	8 lbs. soap.
	100 gallons water.

In the second preparation the oils should be mixed first; then add the water heated with the soap. If properly mixed, this preparation should have the appearance of rich cream.

No. 3.

6 gallons whale and seal oil.
10 ,, mineral oil.
8 lbs. soap.
100 gallons water.

This is prepared in the same way as the preceding mixture. It is, of course, cheaper, but is more apt to make the cards dirty.

HAND-BATCHING.

The system technically known as "hand-batching" is now seldom adopted, except for the finer qualities of fibre. In this system the jute is batched in the same way as tow, not only with the view of properly mixing the different varieties of which the batch may be composed, but in order that the oil and water may get thoroughly and evenly distributed over the whole. Besides this, the heat that is generated by lying in bulk softens the material, and makes it more pliable. Stalls, as in tow, should be formed for batching the jute, say, 10 feet by 3½ feet. The streaks which form the bale should be sub-divided into 6 or 8, one bale thus comprising 160 to 180 of the smaller ones. Great care must be exercised when laying these streaks in rows to have the heads where the piece is doubled placed evenly. As each row is added, the oil is first spread, and afterwards the water, by means of a can. The distribution of the liquid in proper quantities is a matter of great difficulty, requiring, besides careful workers, cans of dimensions suitable to the requirements of the batch. The oil and water are sometimes applied in hand-batching without being heated. This plan may do very well in warm weather, and if the batch can be allowed to stand a sufficient time, say twenty-four to thirty-six hours; but if the weather be cold, and especially if the time be limited to eighteen or twenty hours, the water, at least, is better to be heated. Great care, however, should be taken to prevent overheating while in the batch, as in this case the jute assumes a clammy nature and does not go through the subsequent processes freely. To prevent the heat passing off, the batch, after being completed, should be covered with a cloth.

One of the greatest difficulties in the subsequent processes is the fluctuation in the condition of the jute, due to slow or rapid evaporation, owing to the state of the atmosphere and other causes. This must be taken into consideration in proportioning the water to the batch,

in order to keep the jute in such a moist condition as will cause it to work well in carding, &c.; and precautions must be taken to keep it in a uniform state whilst passing from one stage to another. After taking a certain quantity from a batch, it must not remain uncovered during the night, nor, indeed, for any lengthened period, as the part exposed will lose a certain part of its weight by evaporation. For the same reason, if a batch is small, it should be well treaded, and, after covering, a weight should be placed on the top.

MACHINE-BATCHING.

As we have said, the great bulk of spun jute undergoes the process technically known as "machine-batching." The expense attending this process is less, and, independent of this, machine-batching is more practicable where large quantities are being daily used. A certain number of bales of the various qualities forming the batch are arranged alongside the softening machine. This machine varies in construction, the most common in use having 20 to 34 pairs of fluted rollers. The rollers are variously fluted, straight and spirally. Suitable pressure is brought to bear upon the top row. Various methods are adopted of spreading the oil and water from receptacles placed above the machine. The great object aimed at in the various contrivances is to spread the liquids evenly. The water is generally applied about the second or third pair of rollers, and the oil on the second or third pair succeeding. In some cases it is found advantageous to distribute the oil and water nearer the centre of the machine, in order that the first rollers may clean off any loose root. The oil and water are heated in some cases by steam pipes passing through the liquids, whilst in others the oil cistern is heated by being placed inside the one containing the hot water. Ordinary water cocks are used for regulating the quantity, but, when the distribution takes place by means of rollers in troughs, the speed of

these, and consequently the quantity spread, may be regulated by the pinions driving them. It is an important point to have the jute properly softened, to make it work smoothly in the preparing room, and prevent the yarn being hairy. The amount of softening required depends on the nature of the jute and the size of yarn for which it is intended. From the difference which exists between the root and crop end of jute it is impossible, with the same amount of softening, to have both ends exactly alike, as in softening the root end sufficiently the softer crop end would be materially damaged. Hence the great diversity of opinion as to the proper amount of softening the different sorts require, and also in regard to the merits of the various machines in use. An appliance has been lately introduced to batch on the card. The jute goes first through an ordinary softening machine, having the water only spread over it. On coming to the breaker card the jute, before entering the shell feed roller, has the oil spread over it by means of a row of wires from which the oil drops, these receiving it from a roller revolving in a trough which can be supplied with any quantity required from a small cistern above the card.

Besides the methods of batching already mentioned, many more may be found in use, according to various circumstances with which individual spinners have to contend. In the case of fine yarns, the parts of the jute to which much root is attached are removed after leaving the softening machine. This is accomplished in two ways. The most common way is to cut off the bad part by means of a large steel blade or knife, erected near the softening machine. The other method is by means of a machine called a snipper, which is similar to a teaser with a reversing motion. This machine is used principally for good warp yarns, and makes an end superior to the cut ends from the knife, but the system is more expensive. The jute is now tied up in bunches, the weight of which depends on the amount to be spread at the breaker.

Jute Carding.

As comparatively little jute is used for making jute line yarns, it is necessary, owing to the length of fibre, as well as the coarse unsplit ends which are to be found even in the finer sorts, to put it through a breaker, in order to make it into jute tow, delivering it in a single sliver for the finisher card. (For particulars of construction, also of finisher card, see page 211.) An inclined feeding sheet leads to the rollers upon which the person attending the machine spreads the jute evenly, and as the clock for regulating the amount to be spread is generally on the breaker the necessity for careful work is apparent. The root end is spread first, and the distance the next piece overlaps depends upon the weight of fibre in the crop or top end of the streak. The jute is spread in pieces, and, if it has previously been hand-batched, great assistance may be given to the feeder if the pieces into which the jute is split for that purpose are made as near a uniform size as possible. Jute cards are fed by means of a single roller, termed a shell feeding roller, differing in this respect from tow cards which have two feeding rollers. The following will give an idea of the "setting" or distance between the various parts:—

Distance between—

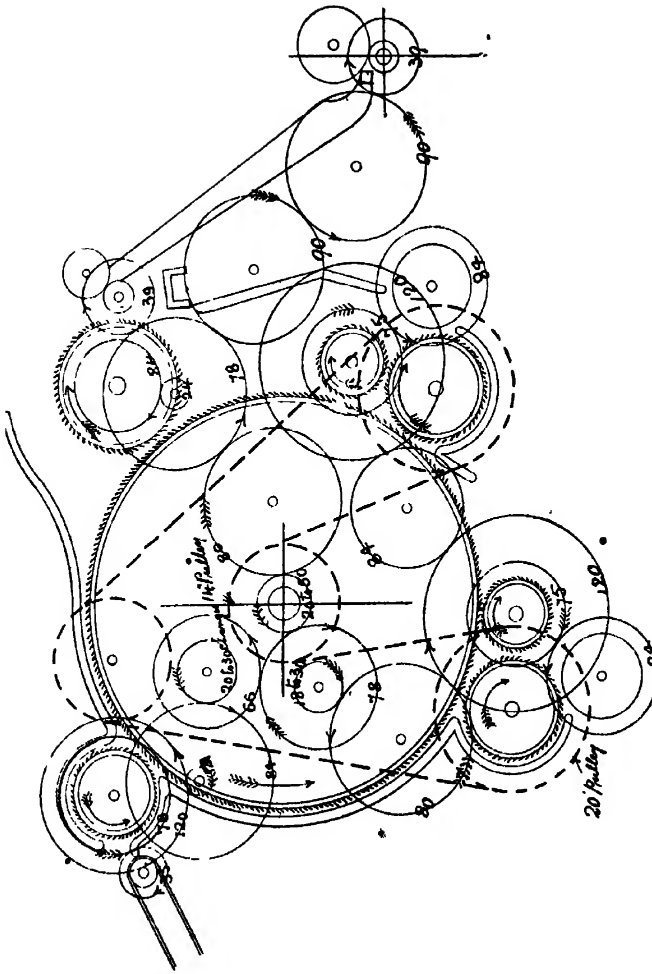
Feeding roller and cylinder, -	$\frac{1}{4}$	in.
Shell and cylinder, - -	$\frac{1}{4}$ to $\frac{5}{16}$	„
Feeding roller and shell, -	15 to 16	w.g
1st stripper and cylinder, -	10 to 13	„
1st worker, - - - -	7 to 10	„
1st stripper and 1st worker, -	10 to 14	„
2nd stripper and cylinder, -	11 to 14	„
2nd worker and do., -	8 to 11	„
2nd worker and 2nd stripper, -	11 to 14	„
Doffer and cylinder, - -	12 to 14	„
Front roller and doffer, - -	10 to 14	„
Top pressing roller and do., -	$1\frac{7}{8}$ to $2\frac{1}{2}$	ins.

If the doffer delivers from below, the respective distances between it and the front roller and the top pressing roller require to be reversed.

The foregoing may serve as a guide, but variations to a considerable extent are necessary, owing to the different speeds at which the cards are driven, the length into which the fibre requires to be broken, &c. Tin cylinders are placed below the rollers, under the card, for the purpose of preventing undue waste, and are driven from either the stripper or the worker. These, as well as wood covers, should have ⅜ inch of space between them and the rollers. The pressing doffing roller is about 7 inches diameter, deeply scratched about ½ inch apart. Wooden lags or staves are used on the cylinder and the other rollers. The workers, however, are sometimes clothed with leather filleting. Care should be taken to keep the pins on the cylinder in proper working order, by removing the staves, and having them refilled from time to time. No waste should be passed through a breaker used for warp yarns, or even through one used for light weft. The calculations in connection with cards are similar to those for tow, so that it is almost superfluous to repeat examples of calculations previously given, except to give a general idea of the speed and dimensions of the respective parts.

We give here a drawing of a jute breaker card, made by Messrs Combe, Barbour, & Combe, Limited, Belfast, from which the following calculations can be followed:—

Cylinder, -	48	in. dia.	=	12·56	ft. circum.
Feed roller, -	10	in. „	=	2·618	„
Strippers, -	11½	in. „	=	3·01	„
Workers, -	8	in. „	=	2·094	„
Doffer, - -	15	in. „	=	3·927	„
Drawing roller,	4	in. „	=	1·047	„
Delivery roller,	4¼	in. „	=	1·112	„



JUTE BREAKER CARD.
(MESSRS COMBE, BARBOUR, & COMBE, Ltd.)

Speeds, Pinions, &c.	Speed.	Circum.	Surface Speed in ft. per min.
Cylinder, $\frac{165 \times 24}{22}$	$= 180$	$\times 12·56$	$= 2260·80$
Feed roller, $\frac{180 \times 35 \times 25 \times 21}{66 \times 84 \times 120}$	$= 4·971$	$\times 2·618$	$= 13·014$
Strippers, $\frac{180 \times 14}{20}$	$= 126$	$\times 3·01$	$= 379·26$
Workers, $\frac{180 \times 35 \times 24}{78 \times 120}$	$= 16·153$	$\times 2·094$	$= 33·824$
Doffer, $\frac{180 \times 35 \times 24}{78 \times 84}$	$= 23·077$	$\times 3·927$	$= 90·622$
Drawing roller, $\frac{180 \times 35}{39}$	$= 161·538$	$\times 1·047$	$= 169·130$
Delivery roller, $\frac{180 \times 35}{39}$	$= 161·538$	$\times 1·112$	$= 179·630$

Draft of Card by Surface Speed, $\frac{179·630}{13·014} = 13·805$

Draft by Gearing, $\frac{66 \times 84 \times 120 \times 4\frac{1}{4}}{25 \times 21 \times 39 \times 10} = 13·805$

Finisher Cards.—These cards are full circular for the finer sizes of yarn, and half circular for the coarser sizes. Full circular cards deliver on the same side as the feeding roller. Half circular cards deliver on the opposite side from the feeding roller. Again, whereas half circular cards have generally only two or three pairs of rollers, full circular cards have four or five pairs. The sliver from the breaker may be supplied to the finisher cards either in cans or made into laps or balls, similar to tow. The latter method (forming the slivers into laps) is the less expensive, less waste being made, but is open to several

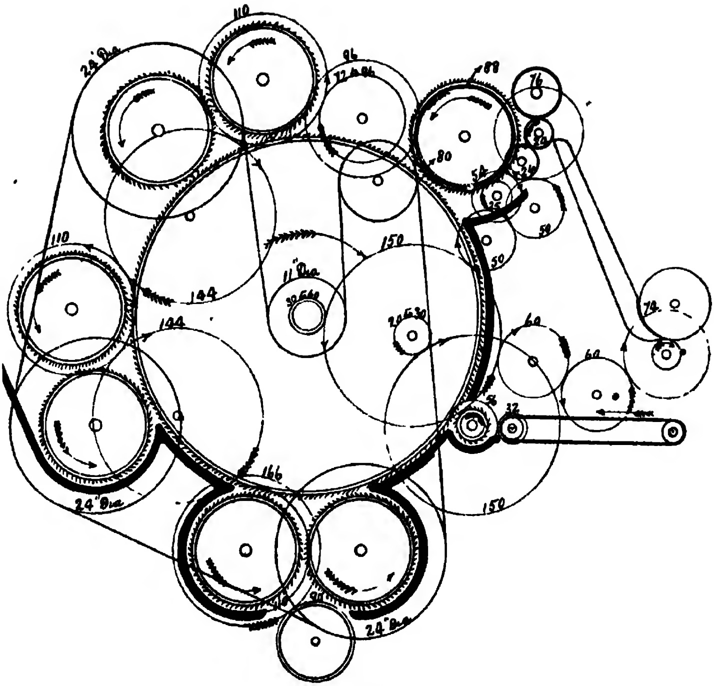
objections, one of these being the extra tossing the slivers undergo. The use of cans does away with this objection, but is not so simple, and, consequently, it is a matter for consideration which method is best suited for different places. It is scarcely necessary to point out that in either case slivers may break at the finisher, and this occurring with balls is certainly the most difficult to set right without disarranging the other slivers on the balls and making waste. From the following an idea may be formed of the setting of finisher cards:—

Distance between—

Feeding roller and cylinder, -	$\frac{1}{4}$	in.
Shell and cylinder, - -	$\frac{5}{16}$	,,
Feeding roller and shell, -	15	w.g.
1st stripper and cylinder, -	11 to 14	
1st worker do. -	10 to 12	
1st stripper and 1st worker, -	11 to 14	
2d do. and cylinder, -	11 to 14	
2d worker do., -	10 to 12	
Do. and 2d stripper, -	12 to 14	
3d stripper and cylinder, -	11 to 14	
3d worker do., -	11 to 13	
3d worker and 3d stripper,	13 to 14	
4th stripper and cylinder, -	12 to 14	
4th worker and cylinder, -	12 to 14	
4th worker and 4th stripper.	13 to 14	
Doffer and cylinder, - -	13 to 14	
Front roller and doffer, -	10 to 14	
Top pressing roller and cylinder,	$1\frac{3}{8}$ to 2	ins.

If the doffer delivers from below, the respective distances between it and the front roller and the top pressing roller require to be reversed.

Tin cylinders are placed under the rollers, as in the breakers, and there should also be between the rollers and covers a similar space of $\frac{3}{8}$ inch. The draft required on jute cards is shorter than on those for tow, seldom exceeding 20, and not often below 12, an average for finisher cards being 15. We give here a drawing of a



JUTE FINISHER CARD.

(Messrs COMBE, BARBOUR, & COMBE, Ltd.)

jute finisher card made by Messrs Combe, Barbour, & Combe, Limited, Belfast, from which the following calculations can be followed:—

Cylinder, - -	48	in. dia.	= 12·56	ft. circum.
Feed roller, -	$4\frac{1}{2}$	"	= 1·178	"
Strippers, -	15	"	= 3·927	"
Workers, -	15	"	= 3·927	"
Doffer, - -	15	"	= 3·927	"
Drawing roller,	4	"	= 1·047	"
Delivery roller,	$4\frac{1}{4}$	"	= 1·112	"

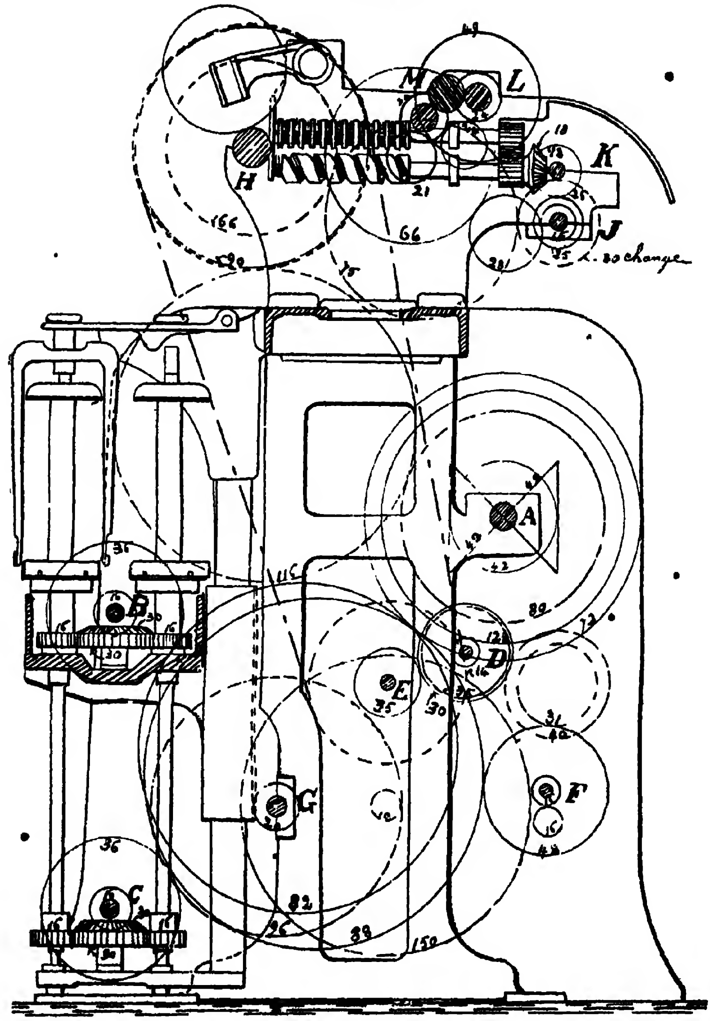
Speeds, Pinions, &c.	Speed.	Circum.	Surface Speed in ft. per min.
Cylinder, $\frac{165 \times 16}{22}$	= 120	× 12·56	= 1507·20
Feed roller, $\frac{120 \times 40 \times 25}{150 \times 150}$	= 5·33	× 1·178 =	6·278
Strippers, $\frac{120 \times 11}{24}$	= 55	× 3·927 =	215·985
Workers, $\frac{120 \times 40 \times 24 \times 25 \times 80 \times 72}{76 \times 54 \times 88 \times 96 \times 110}$	= 4·349	× 3·927 =	17·078
Doffer, $\frac{120 \times 40 \times 24 \times 25}{76 \times 54 \times 88}$	= 7·974	× 3·927 =	31·313
Drawing roller, $\frac{120 \times 40}{76}$	= 63·158	× 1·047 =	66·126
Delivery roller, $\frac{120 \times 40}{74}$	= 64·864	× 1·112 =	72·128

Draft of Card by surface speed, $\frac{72 \cdot 128}{6 \cdot 278} = 11 \cdot 488$

Draft by gearing, $\frac{150 \times 150 \times 4\frac{1}{4}}{25 \times 74 \times 4\frac{1}{2}} = 11 \cdot 488$

ARRANGEMENT OF CARD PARTICULARS.

Particulars.	Teaser.	Coarse Breaker.	Breaker.	Half-Circular Finisher.	Finisher.
Diameter of Cylinder, in feet, ...	4	4	4	4	4
Width of do., do., ...	4	6	6	6	6
Number of Strippers, ...	2	2	2	3	4
Do. Workers, ...	2	2	2	3	4
Do. Doffers, ...	1	1	1	1	1
Diameters of Strippers, in inches, ...	10	15	15	19	11
Do. Workers, do., ...	7	$8\frac{1}{2}$	$8\frac{1}{2}$	$7\frac{1}{2}$	$8\frac{1}{2}$
Do. Feeders, do., ...	14	19	19	14	16
Do. Doffers, do., ...	8	$9\frac{1}{2}$	$9\frac{1}{2}$	8	$4\frac{1}{2}$
No. of wire and pitch of pins on Cylinder	10	$11-\frac{3}{4}\times\frac{3}{4}$	$12-\frac{3}{4}\times\frac{3}{4}$	$14-\frac{9}{16}\times\frac{1}{2}$	$15-\frac{7}{16}\times\frac{7}{16}$
Do. do., Strippers,	12	$13-\frac{1}{2}\times\frac{1}{2}$	$14-\frac{3}{8}\times\frac{7}{16}$	$13-\frac{7}{16}\times\frac{3}{8}$	$\left\{\begin{array}{l}1,2=14-\frac{3}{8}\times\frac{3}{8}\\3=15-\frac{3}{8}\times\frac{3}{8}\\4=16-\frac{3}{8}\times\frac{3}{8}\end{array}\right.$
Do. do., Workers,	10	$10-\frac{1}{2}\times\frac{1}{2}$	$10-\frac{3}{8}\times\frac{7}{16}$	$\left\{\begin{array}{l}1=12-\frac{1}{2}\times\frac{3}{8}\\2,3=13-\frac{3}{8}\times\frac{3}{8}\end{array}\right.$	$1,2=13-\frac{3}{8}\times\frac{3}{8}$ $3,4=14-\frac{3}{8}\times\frac{3}{8}$
Do. do., Doffers,	12	$14-\frac{1}{2}\times\frac{1}{2}$	$14-\frac{3}{8}\times\frac{7}{16}$	$14-\frac{7}{16}\times\frac{3}{8}$	$16-\frac{3}{8}\times\frac{3}{8}$
Do. do., Feeders,	10	$12-\frac{1}{2}\times\frac{9}{16}$	$12-\frac{3}{8}\times\frac{9}{16}$	$13-\frac{1}{2}\times\frac{1}{2}$	$14-\frac{3}{8}\times\frac{3}{8}$



Jute Roving Frame.

(Messrs Combe, Barbour, & Combe, Ltd.)

A Driving Shaft.	D Counter Shaft.	G Back Shaft.	K Back Shaft.
B Bobbin Driving Shaft.	E Cone Shaft.	H Front Roller.	L Back Roller.
C Spindle Driving Shaft.	F Traverse Shaft.	J Back Shaft (Bottom).	M Back Roller.

JUTE PREPARING.

The machinery for preparing jute is similar to that used for preparing tow. As jute yarn is heavier than ordinary tow yarns the machinery is coarser. Machinery, however, adapted for jute may be used to prepare tow for the same size of yarn, and *vice versa.*

In jute preparing the drawing frames now principally in use are what are termed push bar or chain drawing frames. On page 221 we give a drawing of a patent push bar drawing frame made by Messrs Combe, Barbour, & Combe, Ltd., Belfast. These enable a much larger quantity to be put over per day than over the ordinary faller. In jute roving frames the faller is still used, but at the present moment a leading firm of machine makers is adopting the push bar also to the roving frame, and if they can do so successfully there is no doubt but that the faller in jute preparing will be done away with.

Again, whereas wooden pressing rollers are used in the flax and tow trade, these are in the case of jute substituted for fluted iron rollers for the heavier sizes, and iron rollers covered with leather for the lighter sizes. The drawing rollers, working with leather pressing rollers, may be scratched. The generality of machine makers make the drawing rollers of drawings and rovings on the irregular fluting principle, or what may be called fluted out of pitch.

The various calculations in connection with the drawing and roving frames are exactly similar to those for tow and machinery already given. We give a drawing showing the arrangement of gearing for a jute roving frame made by Messrs Combe, Barbour, & Combe, Ltd., Belfast, and also an end view drawing of a jute roving frame made by the same firm, from which, on referring to flax preparing, the various calculations in connection with these roving frames can be followed. The weight of rove is denoted in the number of ounces per 100 yards, or in the number of yards per ounce. The most common calculations are for finding the weight

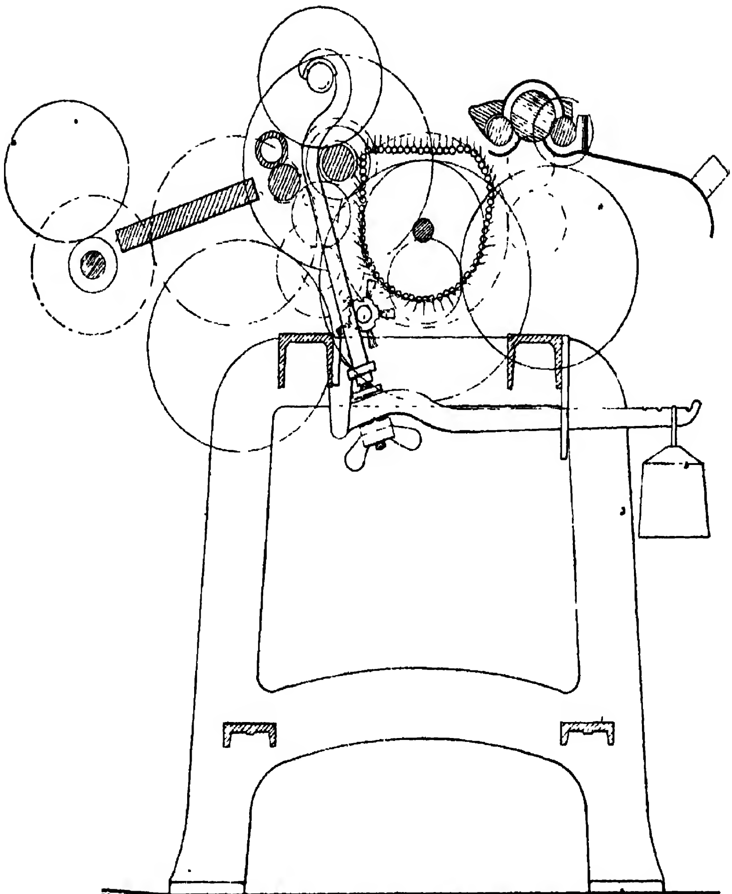
of sliver per 100 yards to be delivered from the finisher card, or the weight to be spread on the feed sheet of the breaker card, either on one yard or during one round of the clock, which is driven from the feeding roller of the breaker. An example and explanation of the above calculations are given in "Tow Preparing." The following is a similar calculation for finding the weight to be spread on a breaker:—

Weight of Rove required 7 *ozs. per* 100 *yards.*

Draft on the roving,		7	Slivers into one,	1
Do.	2nd drawing,	6	„	2
Do.	1st do.,	$5\frac{1}{2}$	„	8
Do.	finisher card,	16	„	10
Do.	breaker,	15		

$\frac{7 \times 7 \times 6 \times 5{\cdot}5 \times 16 \times 15}{2 \times 8 \times 10 \times 16} = 152$ lbs. per 100 yards to be spread on the breaker. We now ascertain the length of the clock to be, say, 25 yards in one round. As the weight required to be spread at the feeder, namely, 152 lbs., is for 100 yards, we have one-fourth of this amount for 25 yards, or one round of the clock, $100 : 25 :: 152 = 38$ lbs. to be spread in one round of the clock. The quantity of waste estimated to be made before reaching the rove must be added in a manner similar to that explained in "Tow Preparing." Allowing 8 per cent. for waste, we have $\frac{38 \times 100}{100 - 8} = 41{\cdot}3$ lbs. to be spread in one round of the clock, and having already ascertained this length to be 25 yards, we can, if necessary, find the weight per yard thus, $= \frac{41 \times 3}{25} = 1{\cdot}65$ lbs., or 1 lb. $10\frac{1}{2}$ oz. to be spread on each yard of the feeding cloth.

From the nature of the jute fibre, especially if it be not well softened, it is very liable to run over the top of the gills. Provision should be made in the relative speeds of the falls and retaining rollers for the gills to pin properly. Unsplit root in the fibre will cause the same inconvenience, especially if the gill be intended



PATENT PUSH BAR DRAWING FRAME.

(Messrs COMBE, BARBOUR, & COMBE, Ltd.)

for finer work. The rising of the fibre above the gills is much more injurious in rotary frames than in spiral frames, owing to the greater distance between the rollers and the part above the gills in rotary frames. At the same time, root will cause the fibre to be raised up much more readily in rotaries. One of the most frequent causes of bad work is the tendency the sliver has to lap round the roller. If jute arrives in a proper condition at the "preparing," and the rollers are kept in a thoroughly clean state, with a polished surface, this may be generally avoided. In some cases a pair of small rollers are fixed, between which the sliver enters on leaving the drawing and pressing rollers, and these prevent lapping. If too small a quantity of oil, or oil of inferior quality, be given to the jute, the sliver plates are apt to rust, and thus cause light slivers to break. Great attention should be paid to the relative speeds of the delivering boss and delivering roller. It is necessary to have sliver cans in a proper state of repair.

The various calculations of draft and twist standing numbers for roving frames are exactly similar to those for flax or tow. The most common size of jute roving frames is that made for a bobbin 10 ins. by 5 ins.

Jute Spinning.

Jute spinning is in every way similar to tow spinning, the frames being suitable for either. As the sizes of jute yarn are generally heavier than for tow, the spinning frames are also coarser. The pitch of the spinning frames used for jute is from 3½ inches to 5 inches, and the yarns commonly spun on them are as follows:—

Pitch.	Size of yarn.
3½ to 3¾ inches, - - -	5 to 7 lb.
4 inches, - - - -	8 to 12 lb.
4¼ to 4½ inches, - - -	10 to 20 lb.
5 inches, - - - -	20 to 40 lb.

Owing to the weak nature of jute, as compared with good tow, shorter drafts are required. From the length

and strength of fibre in the rove, the amount of binding, and the proper place at which it should be most bound, may be determined. The tension just immediately before entering the tin conductors should be easy, without any strain. The rove should not be twisted more than is required to make it come off the rove in spinning, and jute rove will do with less twist than tow rove, owing to the moisture it receives in batching, which serves to hold it together. The mode of calculating the draft and twist standing numbers is the same as in dry spinning, the gearing being arranged in a similar manner. The short rules given in dry flax spinning for finding the draft from the weight of 100 yards of rove, namely, multiplying the weight of drs. by ·6, and dividing by the lbs. per spindle wanted, apply also to jute. If, however, the weight be given in ounces, we have first to reduce the weight to drs. by multiplying by 16.

Example.—If we have 100 yards of rove weighing 10 ounces, and require draft for yarn 16 lbs. per spindle—

$$\frac{10 \times 16 \times \cdot 6}{16 \text{ lbs.}} = 6 \text{ draft.}$$

In light warps, say, 5 to 7 lbs., this rule will be found to work correctly; but in wefts, where there is not so much twist, the draft will require to be a little shorter. In heavy warp sizes the draft will require to be a little longer. In heavy weft sizes this rule will be found to work correctly. Another rule is given in "Dry Spinning" to find the draft without any addition to counterbalance the increased weight caused by contraction, leaving any percentage that it may be deemed necessary to add.

Changing from one size of yarn to another may be done by proportion; but, if the difference in the size of yarn be great, a relative allowance must be made for contraction by twist. In "Dry Spinning" is explained the way in which to change the drawing roller pinion if a suitable change pinion cannot be obtained, or if the

drawing roller pinion be the change pinion, to change also the stud pinion.

The amount of spinning draft best suited to jute is shorter than in tow, although it will be commonly found that jute spinners use fully as long draft as flax tow spinners; 7 to 9 spinning draft for 7 lbs. being quite common.

The amount of twist given to jute yarns varies as in tow yarns. For 7 lbs. warp a common twist is at the rate of 8½ to 9 for 3 lbs. and for 12 lbs. warp and upwards at the rate of 8 to 8½ for 3 lbs. Wefts require less, say 7 lbs. at the rate of 6 to 6½, and heavy sizes at the rate of 5½ to 6 for 3 lbs. On reference to the twist table already given, the exact twist per inch for each size at these rates may be seen. Warps intended to be used double are twisted a little less than those to be used single, and spinners usually twist yarn going direct to their own looms a shade less than yarn intended for sale.

We give here a drawing of a jute spinning frame made by Messrs Combe, Barbour, & Combe, Ltd., Belfast, showing the gearing, &c., from which the various calculations as to draft, twist, &c., may be followed on referring to "Dry Spinning."

REELING.

Reels for jute yarn are in construction similar to those previously described for flax and tow yarns. The bobbins are made to run perpendicularly or horizontally. When heavy sizes of yarns are reeled it is essential to have them evenly spread by the traverse motion. In consequence of the liability of jute yarn to vary in weight to a considerable extent, the yarn must be weighed at intervals to check the spinning of too heavy or too light yarns. If heavy spun yarn has to be counterbalanced in bundling by spinning yarn below the proper weight, it makes very uneven cloth, and in the case of warps the light yarn will damage its working in the loom. When a new size has begun spinning,

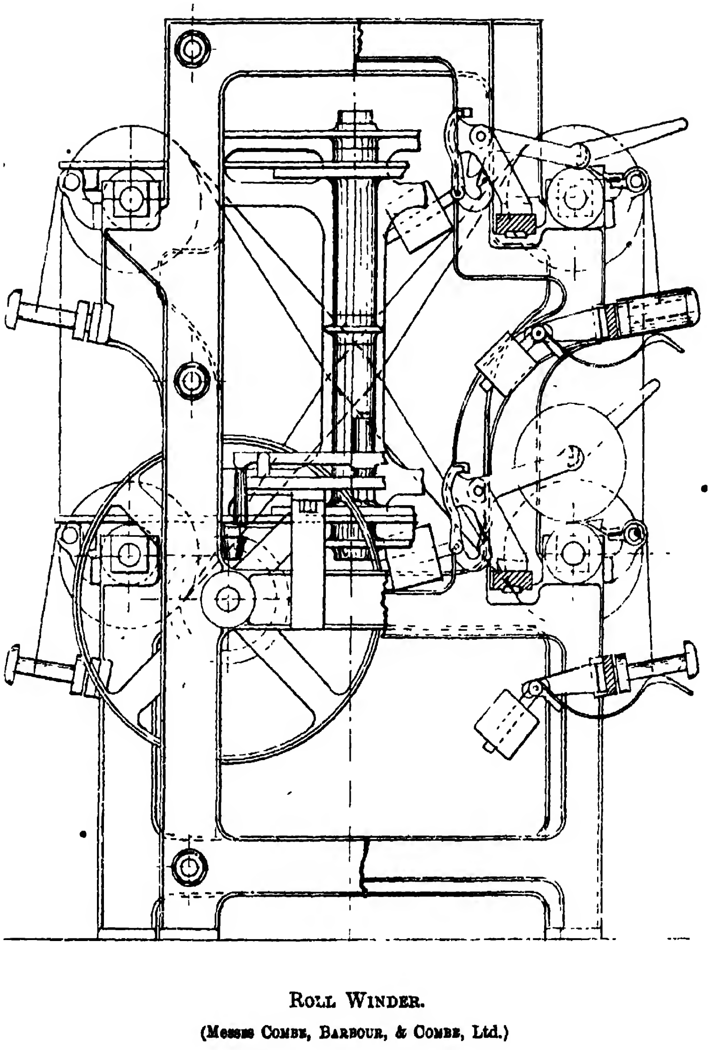
a few cuts, from say six bobbins, should be reeled as soon as possible, and any error in the weight checked. It is hardly necessary to mention that in reeling three cuts to ascertain the weight of the yarn, the weight in ounces will be found to correspond with the lbs. per spindle; three cuts and one ounce being the one-sixteenth part of one spindle and one pound weight respectively. Faults which should be avoided are mentioned in "Reeling" in a previous part of this book. Knots are more conspicuous in jute yarn owing to the yarn being heavier, necessitating careful supervision to prevent improper ones.

Within recent years the machine called the roll winder has been introduced by jute spinners, and it is now generally prevalent instead of reeling warp yarns to have them made into rolls by means of this machine, which is done from the spinning bobbins. These rolls are taken from the spinning mill to the warping department and warped direct, thus saving the process of reeling and of winding from the hank, with the corresponding decrease in waste, labour, &c. Weft jute yarns also are now made into cops direct from the spinning bobbin, and are sent to the factory in this state, and manufacturers buy from spinners cops and rolls, thus saving themselves the labour in each case of coping and warping from the hank.

We append sketches of each of these machines, which are made by Messrs Combe, Barbour, & Combe, Ltd., Belfast.

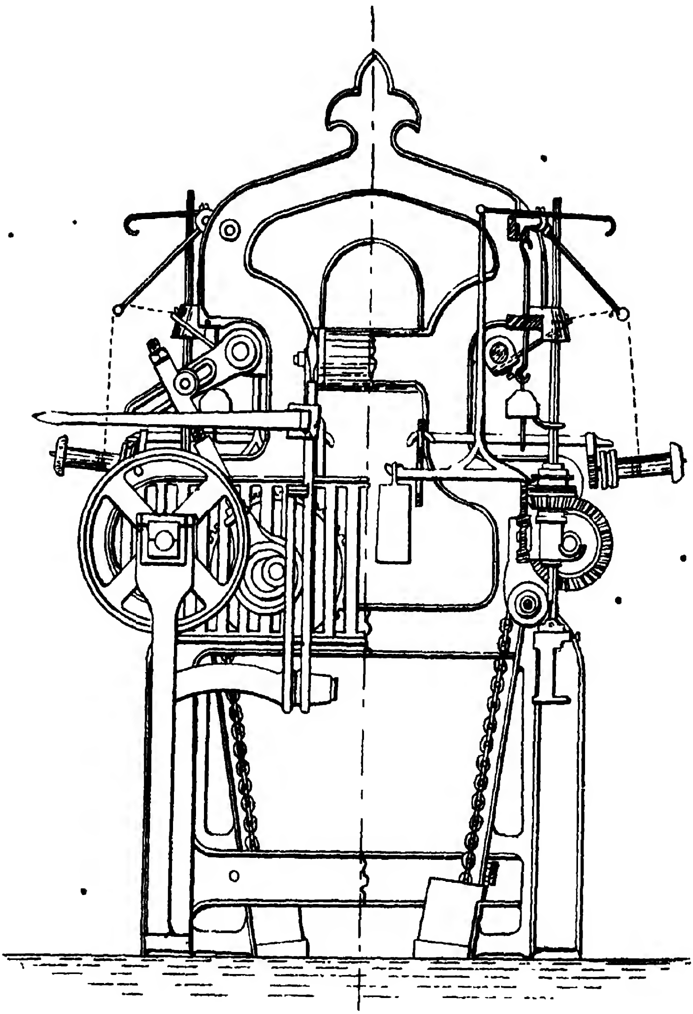
BUNDLING.

Jute yarn is made up in long bundles on stools similar to those for dry spun yarns. These stools have generally only three pins on each end. A table that can be raised by a pinion and rack will be found very convenient, especially for heavy yarns.



ROLL WINDER.

(Messrs COMBE, BARBOUR, & COMBE, Ltd.)



Cop Winding Machine.
(Messrs Combe, Barbour, & Combe, Ltd.)

Yarn Table.

English Reel.

1 Thread	=			3	Yards	=	108	Inches.
100 Threads	=	1 Lea	=	300	"	=	10,800	"
10 Leas	=	1 Hank	=	3,000	"	=	108,000	"
20 Hanks	=	1 Bundle	=	60,000	"	=	2,160,000	"

Small Reel.

1 Thread	=			1½	Yards	=	54	Inches.
100 Threads	=	1 Lea	=	150	"	=	5,400	"
10 Leas	=	1 Hank	=	1,500	"	=	54,000	"
40 Hanks	=	1 Bundle	=	60,000	"	=	2,160,000	"

Scotch Reel.

1 Thread	=			2½	Yards	=	90	Inches.
120 Threads	=	1 Cut	=	300	"	=	10,800	"
2 Cuts	=	1 Heer	=	600	"	=	21,600	"
6 Heers	=	1 Hank	=	3,600	"	=	129,600	"
4 Hanks	=	1 Spindle	=	14,400	"	=	518,400	"

Irish Reel.

1 Thread	=			2½	Yards	=	90	Inches.
120 Threads	=	1 Lea	=	300	"	=	10,800	"
12 Leas	=	1 Hank	=	3,600	"	=	129,600	"
16 Hanks and 8 Cuts	=	1 Bundle	=	60,000	"	=	2,160,00	"

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